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A review on organic liquid fertilizers and their potential impacts on the growth and yield of agricultural crops

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Abstract

It is assumed that Liquid Organic Fertilizer (LOF) can serve as a supplement or an alternative to Solid Organic Fertilizer (SOF). They are made by soaking nutrient rich materials for several days or weeks to facilitate fermentation through microbial activity. The most common advantage affiliated to LOF is that its ability to serve as an immediately available source of nutrients ensuring fast uptake and provide short term rapid results for quick green up using a small quantity. The SOF contains nutrients in a solid form and that need to be dissolved or decomposed into soil solution before uptaken by the plants. The present study was conducted with the intention of evaluating the organic liquid fertilizers and their impacts on growth and yield of crops by reviewing the published literature. The review of literature under the present study has shown that there are many types of LOF including fresh plant extracts, liquid manure and liquid bio-fertilizer. They are extracted from wide range of materials and by methods especially using locally available materials. Hence, most of them can be home-made at a very minimal cost. Research studies conducted using organic liquid fertilizers have shown lot of positive impacts on crop growth, yield increase and quality and plant protection. Further, there are studies to formulate and test new forms of organic liquid fertilizers using natural substances. The study reveals that liquid organic

fertilizers (LOF) can play an important role in sustaining crop growth and yield while making minimum impact on the environment.

Keywords: *Organic farming, liquid organic fertilizer, crop growth and yield.*

1. Introduction

Organic farming is a holistic way of farming with the aim of conserving the natural resources and safeguarding the soil from further deterioration. Ali et *al* (2011) stated that generally, it avoids use of synthetic fertilizers, pesticides, growth regulators and relies on green manures, crop rotations, crop residues, animal manures, organic fertilizers, and bio pesticides. According to IFOAM and FiBL (2017), 50.9 million hectares of agricultural land are organic and a total of almost 2.4 million organic producers are engaged in farming. Among that, more than three quarters of the producers are found in developing and transition countries. The largest number is reported from India followed by Ethiopia and Mexico.

Since the ancient time, organic fertilizer application has been considered as one of the most important techniques to increase and maintain soil fertility. And also it serves as a source of food for microorganisms living in the soil and increases the number and activity of those microorganisms, therefore, ultimately makes the land fertile (Hadisuwito, 2008). At the same time, farmers have used organic manure for centuries until chemical or inorganic fertilizers were introduced. They confer many benefits to the soil-plant system, which cannot be provided by inorganic fertilizers. However, this practice has been gradually neglected during the last few decades. As a result, physical, chemical and biological properties of soils have gradually degraded. Continuous application of inorganic fertilizer makes soil deteriorating and increases the cost of production, but organic manure maintains the sustainability and builds up soil fertility in favor of crops. Consequently, it ensures a steady release of nutrients to the crops as the organic matter breaks down. Organic materials particularly rice straw, cow dung, green manure, poultry manure and compost have traditionally been used by farmers in organic agriculture. The bulky organic manure contains low nutrient concentrations but liberal and continuous applications build up the organic matter and nutrient content of soil and increase crop production.

Based on above scenario, there are different types of organic fertilizers that can be successfully used to improve the long term soil fertility in many parts of the country. Generally organic fertilizer is made from organic materials. It can be in various forms like solid organic fertilizer (SOF) and liquid organic fertilizer (LOF). Globally there is prevalent use and scientific knowledge of solid organic fertilizers. In contrast, liquid organic fertilizers have largely remained in the background of mainstream scientific literature and little knowledge exists

about them. Moreover, Solid Organic Fertilizer (SOF), as it contains nutrients in a solid form that will need to be dissolved or decomposed into the soil solution before the nutrients results can be seen, it requires moisture and time. Therefore, it is assumed that LOF can have the ability to serve as an alternative to SOF. With the special reference, organic based liquid fertilizers are a good choice for several purposes among other solid organic fertilizers since they bring the same benefit from small amounts of fertilizer. Many LOFs are nutrient rich material, which is soaked in water for several days or weeks to undergo fermentation.

With the improved agricultural technology, organic farmers are introduced with various methods to increase the efficiency of fertigation and ensure the fast uptake of nutrients using LOF. Accordingly, there are different types of liquid organic fertilizer and their differences are mainly in the raw materials used, forms of utilization and the sources of microorganisms (DOAE 2003, Higa and Parr, 1994). Liquid manures are made by fermenting plant material and then extracting in water. Those are designed in the form of liquid to supply the nutritional needs to crops. The dilution rates and ratios between multiple liquid fertilizers can be quickly activated to reflect the growth of the crops.

Liquid organic fertilizer can be used for sustainable farming by increasing the number of beneficial organisms in soil and plant surfaces as an organic approach to plant or soil care. Basically, locally available materials are used in the production of organic liquid fertilizers. There are many liquid fertilizers available for agricultural crops, both commercially prepared and home-made. Most are fast release nutrient sources that can be used anytime throughout the crop cycle giving the farmer a wide range of different combinations of major nutrients, trace minerals and growth promoting elements. Therefore, the proposed review was intended to review the published literature to study the organic liquid fertilizers. Further, this review has revealed and evaluated to identify the plant species and methods used to prepare organic liquid fertilizers and to identify the impacts of organic liquid fertilizers on growth and yield of agricultural crops.

2. Importance of Liquid Organic Fertilizers (LOF)

Natural liquid fertilizers have immense benefits for the soil and crop production. They add soil organic matter, improve soil structure and preserve essential nutrients that crops need in order to grow well.

As cited (Foth and Turk, 1972), if a soil is to produce crops successfully, it must have an adequate supply of all the necessary nutrients which plants take from the soil. If any of these elements are lacking, normal plant growth will not occur. It is supported by the statement of Onwueme and Sinha (1999) and Uwizeyimana (1997). In the context of organic farming, natural organic fertilizers provide a wide spectrum of plant nutrients and improve its soil

physical properties. Furthermore, it encourages insects and worms to burrow into the ground thus improving permeability to a large extent.

Higa and Kanal (1998), examined the EM (Effective Microorganism) technology in agriculture. It is a liquid concentrate comprising very large numbers of such effective microorganisms that have been extracted from the natural world and coexist harmoniously in a liquid state. They concluded that EM technology maintains crop yields without the use of agricultural chemicals or artificial fertilizers, makes the method of farming less expensive and capable of producing high-quality products, produces high yield and preserves the environment.

Previous studies have already shown that the plants treated with organic liquid fertilizer produced higher yield than recommended inorganic fertilizer. Meg Howe (2017), defined, compost tea is a liquid version of the solid compost material. They contain soluble plant nutrients and a complex community of beneficial microorganisms. It also boosts the plant growth and soil enhancing activity of soil life. Compost tea has been used as a fertilizer, pesticide and fungicide.

Further, some studies conducted on the antifungal and antimicrobial properties of Gliricidia extracts, proved its ability to inhibit the growth of some fungi, bacteria and nematodes. Finding of Ganesan (1994) revealed that the foliage of Gliricidia is higher in its nutritional composition. According to Chatterji (2004), Seaweed extracts have nitrogen, phosphorus and higher amount of water soluble potash, other minerals and trace elements in a readily absorbable form by plants. It also controls deficiency diseases in plants if the concentration of seaweed extract is low. It has been used more effectively in the world in promoting plant growth. Moreover, wormy wash is recommended to spray in the diluted form, to fruit crops and vegetables at the flowering and fruiting stage. This will reduce flower drop. Wormy wash could be applied to the crop either as a plant growth hormone or as a fertilizer (Lionel Weerakoon, 2011).

3. Liquid Organic Fertilizers and their common method of preparation

The use of LOF in agriculture plays a great role in recycling essential plant nutrients, sustaining soil security as well as protecting the environment from unwanted hazards. Accordingly, at present many farmers are practicing alternative techniques to prepare liquid organic fertilizers (LOF). The preparation of LOF is easy, efficient to use and quick and not necessary to wait for long time. In this context, some researchers and scholars reported and showed that the preparation of some LOF is possible from locally available materials in the natural environment. Generally, there are many types of LOF including liquid manure,

readily available fresh form and liquid bio-fertilizer. Detailed classification of LOF is given in the Table 01.

Table 01: Detailed Classification of LOF

Type	Liquid Organic Fertilizer	Source	Common method of preparation
1. Liquid manure	Leaf extract	Lionel weerakoon, 2011.	Fermentation of fresh plant materials in water
	Water-hyacinth extract	Simbarashe Govere et *al*., 2011	
	Glliricidia extract	Peiris and Weerakkody, 2015	
	Russian comfrey	Simbarashe Govere et *al*., 2011	
	Pig weed red root	Simbarashe Govere et *al*., 2011	
	Green tea	Kelly Martin, 2020	
	Lawn and weed fertilizer	Robert Pavlis, 2021	
2. Readily available fresh form	Cow urine	Nelson Licinio C de Oliveira et *al*., (2009)	Use as a readily available fresh form or dilution is done before application of some crops
	Fish pond water	Stone, N.M. and Thomforde, H.K. 2004.	
	Human urine	Ranasinghe et *al*., (2015)	

3. Liquid bio-fertilizer	Fish tonic	Lionel weerakoon, 2011.	Fermentation process (Extracting nutrients and micro-organisms)
	Fruit tonic	Lionel weerakoon, 2011.	
	Jeewamrutha	Lionel weerakoon, 2011.	
	Beejamrutha	Sreenivasa et *al*., 2009	
	Panchagavya	Rathnayake et *al*., 2013	
	Amutha karaikal	Lionel weerakoon, 2011.	
	Compost tea	Min Jeong Kim et *al*., 2015.	
	Compost tea	Meg Howe. 2017.	
	Food waste	Syeda Azeem Unnisa, 2015	
	Seaweed extract	Ganapathy selvam and Sivakumar, 2014.	
	Wormy wash	Lionel weerakoon, 2011.	
	LOF from sugarcane pulp and sugarcane skin	Jajuk Herawati et *al*., 2017.	
	Shrimp extract	Rongting Ji et *al*., (2017)	
	Poultry manure extract	Peiris and Weerakkody, 2015.	

4. Plant species used in preparation of LOF

The source of LOF have significant effect in the nutritional status of the organically managed mandarins. Conversely, these LOF have a great positive impact on plant growth, quality and as well as yield of crops. Many researchers proved the effect of LOF on agricultural crops. Therefore, for the benefit of higher production on agricultural crops, some plant species are used in the preparation of LOF. At the same time literature and particular researches are providing different opinions regarding different plant species used in organic agriculture sector which are shown in the Table 02.

Table 02: Plant species used in production of liquid organic fertilizers

Plant Species	Scientific Name	Source
Water Hyacinth	*Eichhornia crassipes*	Simbarashe Govere et *al*., 2011
Pig weed	*Amaranthus retroflexus*	Simbarashe Govere et *al*., 2011
Gliricidia	*Gliricidia sepium*	Ganesan, 1994
Russian Comfrey	*Symphytum officinale*	Simbarashe Govere et *al*., 2011
Seaweed	*Hypnea musciformis*	Ganapathy Selvam and Sivakumar, 2014.
Sugarcane	*Saccharum officinarum*	Jajuk Herawati et *al*., 2017
Moringa	*Moringa oleifera*	Sanjay Singh et *al*., 2013

Eupatorium	*Eupatorium perfoliatum*	Panda, 2013.
Tithonia	*Tithonia diversifolia*	Fahrurrozi et *al.,* 2015.
Erythrina	*Erythrina variegate*	Lionel weerakoon, 2011.
Leucaena	*Leucaena leucocephala*	Jayasundara et *al*., 2016.
Kappetiya	*Crotalaria retusa*	Rathnayake et *al*., 2013
Lantana	*Lantana camara*	Lionel weerakoon, 2011
Neem	*Azadirachta indica*	Joaquin Adolfo Montes-Molina, 2013
Papaya	*Carica papaya*	Lionel weerakoon, 2011.
Banana	*Musa acuminata*	Lionel weerakoon, 2011.
Pumpkin	*Cucurbita maxima*	Lionel weerakoon, 2011.
Alfalfa	*Medicago sativa*	Robin Sweetser, 2017
Clover	*Trifolium*	Robin Sweetser, 2017
Horsetail	*Equisetum arvense*	Robin Sweetser, 2017
Willow	*Salix alba*	Robin Sweetser, 2017
Dandelions	*Taraxacum officinale*	Robin Sweetser, 2017
Stinging nettle	*Urtica dioica*	Robin Sweetser, 2017
Chicory	*Cichorium intybus*	Robin Sweetser, 2017

4. Effect of Liquid Organic Fertilizer on crop productivity in Sri Lanka

Addition of organic matter in the soil is a well-known practice to increase crop yields. Many researchers reported that an organically managed field ensures the sustainable usage of resources, high yield for crops without over reliance on costly inputs, and environmental and biodiversity protection. Although, many research studies showed positive impacts of LOF on crop growth, quality, yield and plant protection, in Sri Lankan context, a limited number of literature is available at present.

Rathnayake et *al.,* (2013) revealed that rice plants sprayed with jeewamrutha produced highest chlorophyll content, plant height, number of tillers, panicle initiation, percentage of thousand grain weight and total yield. As a result, they concluded that application of jeewamrutha is an alternative liquid fertilizer technique for farmers to get high yield with low cost.

Sutharsan and Rajendran (2010) examined the performance of organic liquid fertilizer (Jeevamrutha) on growth and yield of maize. Application of jeevamrutha once a week could increase yield of maize. It resulted in higher leaf area, biomass, number of grains per cob and yield during reproductive and maturity stages.

Peiris and Weerakkody (2015) concluded that the foliar application of Glliricidia leaf extract as the most favorable organic based liquid fertilizer for best growth performance of leaf lettuce compared to Compost tea and Poultry manure.

Further, Sutharsan, Nishanthi and Srikrishnah (2014) reported that Seaweed extract with 20% concentration of foliar application increased shoot dry weight, root dry weight, fruit number, fruit yield per hectare along with Total Soluble Solids and Total acidity content of fruit significantly over the control, while seaweed extract with 100% of foliar application reduced the above mentioned parameters significantly over the control in tomato plants. Therefore, they could conclude that the seaweed extract at 20% concentration level can be used to enhance the growth, yield and quality of tomato plants.

Human urine is a liquid waste rich in essential plant nutrients such as nitrogen, phosphorous and potassium. Ranasinghe et *al*., (2015) tested that to explore the possibility of utilizing human urine in edible crop production as a low cost and effective nitrogen fertilizer. It showed (human urine: nitrogen concentration adjusted to 20% more than the concentration) the highest increase in plant height, leaf area, root dry weight and total nitrogen content of leaves in bean plant and suggested that urine can effectively be used as a nitrogen fertilizer substitute in agricultural production.

5. Effect of Liquid Organic Fertilizer on crop productivity in other countries

Simbarashe Govere et *al*., (2011) tested the nutrient content of organic liquid fertilizers in Zimbabwe. They revealed that Water Hyacinth liquid manure contained significantly high N and P contents, indicating its suitability as a macronutrient fertilizer. All liquid manures had high K contents, particularly Russian Comfrey. Pig weed had high levels of Ca, Zn and Mg suggesting its suitability as a sufficient micronutrient fertilizer. As a result, they concluded that all liquid manures had NPK contents greater than common solid organic fertilizers such as legume green manure and cattle manure used in Zimbabwe.

Jajuk Herawati et *al.,* (2017) reported the performance of LOF obtained from sugarcane pulp waste and skin concentration on soybean yield. The results reported no significant effect of basic fertilizer doses treatment on soybean yield, while LOF concentration of 14.3% gave better result on growth and soybean yield.

Vijayanand et *al.,* (2014) explored that the bio fertilizing efficiency of seaweed liquid extracts of brown alga *(Sargassum wightii)* on the growth, biochemical and yield parameters of cluster bean plant. Results showed that Seaweed Liquid Extract (SLE) at low concentration (1.5%) exhibited better performance in growth and yield parameters. Meanwhile, it consisted of micro and macro nutrients, vitamins, growth hormones and other constituents, thus the extract might be very much useful to the crops but the concentration should be appropriate to enhance growth and productivity.

Syeda Azeem Unnisa (2015) reported that the food waste is a good source of nutrients and it can be processed into organic liquid fertilizer rather than throwing away. The experiment was conducted by conversion of food waste generated from restaurants, wedding halls and hotels into organic liquid fertilizer through anaerobic process.

Larisa Cremeneac and Tatiana Boclaci1 (2015) tested the impact of applying the liquid organic fertilizer obtained from wormy compost on quality of the maize. It was found that the soaking of maize seed in a liquid organic fertilizer obtained from crude worm compost and drinking water in the ratio of 1:100 and its use as a fertilizer contributed to the early emergence of corn and showed more intense physiological development, improved quality of maize, and increased the content of total nitrogen and crude protein content.

Panchagavya was tested for different crops such as turmeric, paddy, onion, gingelly, sugarcane, banana, vegetables and curry leaf and it was found that it enhanced the growth, vigour of crops, resistance to pest and diseases and improvement of keeping quality of vegetables and fruits (Natarajan, 2002).

Rongting Ji et *al*., (2017) reported that the application of shrimp extract in chrysanthemum produced the greatest increases in root dry weight, total length, surface area, volume, tips, and thick root length, respectively and significantly increased the nutrient contents also. Thus, It could be concluded that the liquid organic fertilizer of shrimp extract is an effective alternative to chemical fertilizer during the early stage of chrysanthemum growth.

Nelson Licinio C de Oliveira et *al*., (2009) evaluated the effect of cow urine on the growth and yield of lettuce. The increase in cow urine concentrations has increased the performance of all lettuce characteristics. The highest yield was obtained with the concentration of 1.25% applied on leaves and with 1.01 % applied to soil, increasing the yield by 28.1% and 47.3% respectively compared to the control.

Catello Pane et *al.,* (2014) reported that the use of compost tea (CT) is becoming interesting for applications in lettuce cultivation. Due to CT, commercial yield and the physiological and nutritional status of the lettuce plants increased, as noticed by foliar chlorophyll content assessment measured during crop cycles. The results provided encouraging indications about the practical application of CT in horticultural organic farming system.

Sivasangari Ramya et *al.,* (2015) revealed that lower concentration (1.5%) of liquid extracts of marine alga (seaweed extract) showed promoting effect on growth and productivity of brinjal plants. It can be concluded that seaweed extracts could be used as eco-friendly liquid biofertilizer to substitute chemical fertilizer and also it plays a pivotal role in organic farming practices toward sustainable agriculture.

In Jasmine, spraying two rounds of Panchagavya, one before the flower initiation and another during bud setting phase ensured continuous flowering and in annual moringa, spraying doubled the stick yield besides giving resistance to pests and diseases. (Vivekanandan, 1999).

Somasundaram et *al*., (2007) revealed that Biogas slurry with Panchagavya combination is adjudged as the best organic nutrition practice for sustainability of maize-sunflower-green gram system by its overall performance on growth, productivity, quality of crops, soil health and economics.

Joaquin Adolfo Montes-Molina et *al*., (2014) found that leaf extract of *Gliricidia sepium* stimulated tomato growth and altered the leaf and fruit characteristics. This was most likely due to its action as a growth regulator and or an inductor of changes in the tomato growth regulation, but not due to its action as an insect repellent. Consequently, leaf extract of *Gliricidia sepium* could be used to stimulate tomato development.

Mohanalakshmi and Vadivel (2008) revealed that ashwagandha plant sprayed with Panchagavya (3%) produced higher number of leaves per plant. Vennila and Jayanthi (2008) revealed that application of 100% recommended dose of fertilizer along with Panchagavya spray (2%) significantly increased the okra plant height and dry matter production.

6. Conclusions

The challenges faced by the Organic Agriculture sector are immense today. The growing agricultural practices ensure more fertilizers for higher yield. At present, wide spread requirement for the production of quality and healthy food to nourish the increasing population is in high demand. In this context, organic liquid fertilizer plays a great role in environment friendly agriculture. Therefore, in summary, this review has provided significant evidence of the important and positive aspects on the use of organic liquid fertilizer in cultivation of agricultural crops. Organic liquid fertilizers ensure the safety of agricultural practice without undesirable impact of chemical fertilizers and have a favorable effect on growth and yield of crops. In the result of studies it was found that generally all organic liquid fertilizers were of higher nutrient content than that of common solid organic fertilizers used by farmers. Thus, in the light of above analysis following conclusions can be made from this review.

- Many farmers are practicing alternative techniques to prepare liquid organic fertilizer from locally available materials in natural environment such as leaf extract, fish tonic, fruit tonic, wormy wash etc.

- The application of LOF, enhances growth and yield of agricultural crops compared to Solid Organic Fertilizers.

- The source of fertilizer has significant effect on the nutritional status of organically managed mandarins.
- Literature and particular researches are providing different opinions regarding different plant species used in production of liquid organic fertilizer.
- Plant growth substances in jeevamurtha and panchagavya help to bring rapid changes in phenotypes of plants and also improve the growth of plants.
- The use of liquid manures is an eco-friendly technique in order to enrich nutrient content of plant and to increase the growth, yield along with the quality of plants.
- Panchagavya, Jeevamruth and Beejamruth are cheaper ecofriendly organic preparations made by cow products namely dung, urine, milk, curd and ghee.
- Plant growth substances in seaweed extract, jeevamurtha and panchagavya help to bring rapid changes in phenotypes of plants and also improve the growth of plants.
- Some plant species (Gliricidia, Tithonia, Erythrina, Eupatorium, Leucaena, and Lantana) have insecticidal, repellent, rodenticidal, antifungal and anti-microbial properties.

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