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Organic Liquid Manures and Bio-Fertilizers: A Tool for Soil and Crop Productivity

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ABSTRACT

Organic farming is an internationally regulated, legally enforced and standardized alternative agricultural paradigm that relies on ecological processes, biodiversity and cycles adapted to local conditions with the aim of sustaining the health of soils, ecosystems and people. Organic farming utilizes various naturally obtaining substances such as manures, bio-fertilizers. Widely recognized among them are manures and bio-fertilizers. Conventionally they are applied as a solid and carrier based, but modern approach of applying in liquid form is gaining reputation. Application in liquid form facilitates better release of nutrients, enhancement of soil microbial activity, improvement of soil aggregation, soil properties and soil health. Some of the famous liquid manures are *jeevamruth*, *panchagavya, beejamruth*, vermiwash, humic acid and sea weed extract. Based on these evidences this paper explores the effectiveness, importance and limitations of most commonly used organic liquid manures. This paper also explains about the usage of liquid bio-fertilizers and their advantages.

Key words: Bio-fertilizer, Growth, Liquid manure, Soil health, Yield.

The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable food production. Liquid manure is considered to be the solution to, since it is a proven fact that the use of liquid organic manures such as *panchagavya*, *beejamruth, jeevamruth*, vermiwash, humic acid, sea weed extract and bio fertilizer results in higher growth, yield and quality of crops. Further in supporting this De Britto and Girija (2006) stated that cow dung in *panchagavya* acts as a medium for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth. *Beejamruth* and *jeevamruth* contains macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Gadewar *et al.,* 2013).

Similar studies showed vermiwash is a liquid fertilizer collected after the passage of water through a column of worm activation. It is a collection of excretory and secretary products of earthworms, along with major micronutrients of the soil and soil organic molecules that are useful for plants (Kaur *et al.,* 2015). Further findings of Reddy *et al.* (2016) stated that, seaweed extract contains growth promoting substances (IAA, IBA, gibberelins, cytokinins, micronutrients, vitamins and aminoacids). Humic acids a source of phosphate and carbon stimulating microflora populations, enhances the protein and nucleic acid synthesis (Ananthi and Vanangamudi, 2014). Liquid bio fertilizer is a special formulation containing high number of desired microorganism with high shelf life and zero contamination. In fact liquid bio fertilizers can overcome many of the biotic and abiotic stress conditions when they are applied to the seed or in the soil (Trimurtulu and Rao, 2014). In this view this article is explore the advantages of organic liquid manures and bio fertilizers over soil and crop productivity.

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Organic liquid manures and bio fertilizers on soil properties

Jeevamruth is recognized as promising liquid manure that could act as a good soil tonic which can enhances the soil physical, chemical and biological properties (Palekar, 2006). Vasanthkumar (2006) further supported this claim that *jeevamruth* act as a tonic to for improving health of the soil. Mohan and Srinivasan (2008) revealed that application of *panchagavya* and effective microorganism solution improved the nutrient status of the soil. In line with this Ansari and Sukhraj (2010) stated that the application of vermicompost with vermiwash recorded a significant influence on the biochemical characteristics, soil micronutrients, physical and chemical properties. Similar findings by Tharmaraj *et al.* (2011) also confirmed that vermiwash application on field maintains soil pH and increased the soil water holding capacity, porosity and moisture content.

The research findings of Aulakh *et al*. (2013) revealed that *jeevamruth* (soil+foliar) (Table 1) application significantly increased the microbial population of a soil of rice-wheat and maize-wheat cropping systems. Also significantly higher biological properties of soil were observed with

panchagavya application during a trail conducted by Phate *et al.* (2014).

In general liquid bio-fertilizer is mainly prepared by beneficial microorganisms that fixes and solubilise or mobilize nutrients which will enhance the soil biological activity. Based on this claim the findings of Raja and Takankhar (2017) revealed that seeds treated with *rhizobium* (10ml/kg of seed) and phosphorus solubilising bacteria (10ml/kg of seed) increases soil available nutrients and organic carbon. Further Bhavya *et al.* (2017) also conclude that 75 per cent of recommended dose of fertilizer + 25 percent of liquid bio fertilizer (seed treatment at the time of sowing) + soil application at 40 DAS enhanced soil chemical properties. Liquid microbial consortium is the only solution for restoration of soil health and fertility (Tamilkodi and Victoria, 2018).

Organic liquid manures and bio fertilizers on growth of the crops

A research conducted by Velmurugan (2005) revealed that seed treatment with foliar application of *panchagavya* (3%) produced taller plants (26.75 cm), higher number of leaves (14.0) as compared to other treatments. Somasundaram and Singaram (2006) further expressed this and found that *panchagavya* spray had positive effect on growth of various field crops. A field experiment was conducted by Kavitha *et al.* (2008) resulted that sea weed extract (phytozyme) application produced significantly higher growth of rice. Higher number of leaves and tillers were observed with sea weed extract application on rice (Sunarpi *et al.,* 2010).

A field experiment conducted by Gore and Sreenivasa *et al*. (2011) found that application of different combination with recommended dose of fertilizer + *Beejamruth* + *Jeevamruth* + *Panchagavya* recorded higher plant height of tomato. Kalaivanan *et al.* (2012) opined that seaweed liquid extract of *Caulerpascal pelliformis* application increases the chlorophyll content on black gram.

Significantly higher plant height, number of leaves and stem was observed with sea weed extract of *Kappaphycus* spray on maize. Manyuchi *et al.* (2013) reported that vermiwash application enhanced the growth of maize .Similar study conducted by Osman *et al.* (2013) reported that combined application of anhydrous ammonia, humic acid and fulvic acid produced significantly higher growth parameters on rice. Saranraj and Imayavaramban (2015) opined that foliar application of vermiwash @ 5 per cent at tillering and flowering stages significantly increased the growth parameters (plant height, number of tillers hill, dry matter production). Studies by Verma *et al.* (2018) showed that 100 per cent recommended dose of fertilizer with vermiwash application recorded higher plant height and leaf area index in redgram.

Application of vermicompost (50 per cent) along with vermiwash foliar spray on linseed gave higher shoot length (138.4 cm), shoot weight (20.02 g) and plant biomass (20.45 g) as compared to other treatments (Makkar *et al.*, 2017). Babu *et al.* (2017) opined that foliar application of 85% concentrated humic acid + fulvic acid enhanced the growth of black gram. For a similar study Priyanka *et al.* (2019) concluded that foliar spray of egg amino acid 1% on rice crop increased the leaf area index and chlorophyll content. Field experiment was conducted by Sutar *et al.* (2019) revealed that *panchagavya* spray at 7.5 per cent recorded significantly higher growth of the cowpea.

Organic liquid manures and bio fertilizers on yield of the crops

Yadav *et al.* (2005) revealed that foliar spray of vermiwash (5 or 10%) registered higher number of pods/plant and number of seeds/pod. Similarly application of egg lime mix with *panchakavya* on crops such as paddy, wheat, banana, vegetables, greens and fruit trees remarkably increased the yield and longevity of the plants. Sea weed extract of phytozyme @ 0.3 per cent twice at 50 per cent flowering and atmilk stages recorded significantly higher growth of rice (Kavitha *et al.*, 2008).

Further Vijakumari *et al.* (2012) soyabean seeds soaked in *panchagavya* (1%) + humic acid (1%) + micro herbal fertilizer (1%) recorded significantly higher pods per plant (9.7) and seeds per plant (21). In line with this Kumar *et al.* (2012) reported that application of FYM (7.5 t/ha) +rhizobium + PSB (10 kg each/ha) + *panchagavya* spray (3% at 30, 60 and 75 DAS) produced higher yield of groundnut. Foliar spray of *panchagavya* @ 3% at flower initiation and 15 days after flowering has recorded significantly higher grain and haulm yield supporting this, Aulakh *et al.* (2013) revealed that field application of *jeevamruth* over two years neither alone nor in combination with chemical fertilizers or farmyard manure influenced the grain yield of rice, maize and wheat in rice-wheat and maize-wheat cropping systems.

Vimalendran and Wahab (2014) found that superior baby corn yield was observed with recommended dose of fertilizers and *panchagavya* spray (3%) at 15, 25, 35 and 45 days after sowing. Supporting this Pramanick *et al.* (2014)

Table 1: Microbial population of various organic liquid manures.

	Bacteria (No. X 10^5)	Fungi (No. X 10^4)	Actinomycets (No. X 10^3)	PSO (No. X 10^5)	Free living N_2 fixers (No. X 10^2)
Panchagavya	26.1	18.0	4.20	5.70	2.70
Beejamruth	15.4	10.5	6.8	2.7	3.1
Jeevamruth	20.4	13.8	3.6	4.5	5.0
Vermiwash	83 x 10^6	8 x 10^3	3 x 10^2		

Sreenivasa *et al.* (2011).

noticed that foliar spray of *Kappaphycus*-sap (15%) enhanced the rice grain and straw yield. Shah *et al.* (2014) further observed that yield of wheat was significantly enhanced by foliar spray of *Kappaphycus*-sap (7.5%). Sea weed extract of *Kappaphycus alvarezii* spraying at tillering stage, panicle initiation and boot stage produced higher will produce high yield. Sidappa (2015) reported that application of *jeevamruth* 1500 l/hec produced significantly higher yield on field bean.

Based on their findings Nath and Singh (2016) reported that, vermiwash obtained from vermicompost of animal agro and kitchen wastes observed on the growth of different Rabi crops *viz*. wheat, gram, pea and mustered. Studies by Boraiah *et al.* (2017) reported that *jeevamruth* application recorded significantly higher fruit yield. Biswas and Bhowmick (2007) opined that liquid rhizobium inoculation (20 ml/kg-seed) increases red gram seed yield. According to Bhavya *et al.* (2017) yield of mungbean was improved by application of 75 per cent recommended dose of fertilizer with 25 per cent liquid bio fertilizer (ST at the time of sowing) and soil application (40 days after sowing).

Field experiment conducted by Thirumeninathan *et al.* (2017) revealed that recommended dose of fertilizer and *panchagavya* foliar spray at 10 days interval produced significantly higher fodder yield of cowpea. Foliar application of 3 per cent *panchagavya* at flowering, 15 DAS after flowering significantly produced higher yield of green gram was reported by Fazulla and Ashock (2017). Similarly Gunasekar *et al.* (2018) opined that *panchagavya* spary 3% (25, 35 and 45 DAS) registered high yield attributes with black gram. Safiullah *et al.* (2018) opined that *jeevamruth* application at 600 l/ha recorded higher cob weight and green fodder yield on maize. Studies by Ramesh *et al.* (2018) revealed that foliar spray (5%) at 20, 40 and 60 days after sowing enhanced that grain and stover yield of maize.

Field experiment conducted by Verma *et al.* (2018) revealed that 100 per cent of recommended dose of fertilizer with vermiwash (100 l/ha) produced significantly higher yield on pigeon pea. Seedling root dip of humic acid with foliar spray at 30 and 40 days after transplanting on rice produced higher dry matter production and yield. Kocira *et al.* (2018) revealed that double spraying by 0.4% solution of Kelpak SL (*Ecklonia maxima* extract) at the 2-3 leaf stage and at the beginning of flowering produced significantly higher yield of common bean.

Organic liquid manures and bio fertilizers on nutrient uptake

Field experiment was conducted by Gore and Sreenivasa (2011) revealed that application of recommended dose of fertilizer along with *beejamruth, jeevamruth* and *panchagavya* enhanced the nutrient concentration of tomato. In line with this studies by Shah *et al.* (2013) revealed that foliar spray of *Gracilaria edulis* (5.0%) on wheat enhanced the nutrient uptake on shoot. Pramanick *et al.* (2014) revealed that 15 per cent *Kappaphycus*-sap with recommended dose of fertilizer recorded significantly higher nitrogen, phosphorus and potassium uptake on grain and straw on rice crop. Application of 15 per cent *Kappaphycus* sap spray with recommended dose fertilizer registered higher nutrient uptake on green gram was stated by Dwivedi and Ashok (2015).

Field experiment was conducted by Pal *et al.* (2015) showed that foliar application of 15 per cent *Gracilaria edulis* sap with recommended dose of fertilizer enhanced the nitrogen, phosphorus and potassium uptake. The application of vermiwash (5%) at tillering and flowering stage significantly increases the nutrient uptake on rice (Saranraj and Imayavaramban, 2015). Application of liquid *azotobacter* and phosphorus solubilising bacteria at 0.625 l/ha with 75 per cent nitrogen and phosphorus significantly increased the nutrient uptake of wheat was stated by Khandare *et al.* (2015).

Foliar application of *Kappaphycus alvarezii sap (10 %)* with recommended dose of fertilizer recorded higher nutrient uptake on hybrid maize was reported by Basavaraja *et al.* (2018). Foliar sprays of *panchagavya* at 15, 30 and 45 DAT @ 3 per cent, seedling root dip of *panchagavya* + one spray at 30 DAT @ 3 per cent + application through irrigation water at 60 DAT recorded higher nutrient uptake on rice grain and straw was stated by Upadhyay *et al.* (2018).

Organic liquid manure and bio fertilizer on production of growth promoting hormones

According to Mooney and Vanstaden (1987) higher phytohormones and plant growth regulators like gibbrellins, auxins and cytokinin was observed with sea weed extract. Blunden (1991) revealed that sea weed extract and bio stimulant application significantly increases the cytokinins, auxins and betaines content. *Panchagavya* significantly produced phytohormones like IAA, GA_3, cytokinin for the growth of crops. (Xu 2001: Somasundaram and Amanulla, 2007).

Somasundaram (2003) revealed that *panchagavya* contains significant amount IAA and GA_3 which increases the crop growth and yield of the crop. Seaweed extracts contain major and minor nutrients, amino acids, vitamins, cytokinins, auxins and abscisic acid and have been reported to stimulate the growth and yield of plants, develop tolerance to environmental stress (Zhang *et al.,* 2003).

Vermiwash (coelomic fluid extraction) contains several enzyme, plant growth hormones such as cytokinins and vitamins along with micro and macro nutrients was stated by Manivannan (2004). Higher amount of IAA, GA, cytokinin, essential plant nutrients, effective microorganisms and biofertilizers like *Acetobacter, Azosprillum* and *Phosphobac-terium* present in the vermiwash (Esakkiammal *et al.,* 2015; Somasundram *et al.,* 2004).

Advantages

Liquid manure

- Natural resources like plants and animals.
- Farmyard manure or plant material.
- Light nutrient boost.
- Absorb roots and through leaf pores.

- Nutrients lacking in soil, roots are stressed.
- Overcome temporary nutrient shortages.
- Catalysts, increasing nutrient uptake by plants.
- Long shelf life, rapidly up taken by plants.

Bio fertilizer

- Longer shelf life 12-14 month.
- No contamination.
- Easy to identification by typical fermented smell.
- Better survival on seeds and soil.
- Easy to apply.
- High commercial revenues.

CONCLUSION

Organic liquid manures are evidently a better alternative for carrier based chemical and organic fertilizers**.** It has the potential to benefit the soil in many ways such as improving soil physical, chemical and biological properties, improving growth, yield and nutrient uptake. It is also efficient in pest and disease resistance without damaging much of the soil. As the world of agriculture is shifting its focus towards soil conserving and environment preservation for the future, the usage of organic liquid manure will be the suitable alternative to the existing fertilizers that satisfies the requirements of modern agriculture without compromising much of the environment.

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