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## Prospect of liquid organic manure on organic bitter gourd cultivation

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### Abstract

Among the cucurbits bitter gourd has got important nutritional and medicinal properties. Its juice is a remedy for diabetic patients. It is consumed in many ways due to the presence of different cucurbitacins. Traditional organic bitter gourd cultivation involves the use of farmyard manure, vermicompost and poultry manure which do not have required yield potential whereas by foliar spray of liquid organic manures like panchagavya, vermiwash, jeevamrit, humic acid etc has important plant nutrients which are required for their growth and productivity. These liquid organic manures are low cost as they are prepared by the farmers itself on their farm and they are easy to prepare and applied. These liquid manures not only increases yield but also improves quality and post-harvest shelf life of produce and maintains soil health and sustainability in the long run.

**Keywords:** Bitter gourd, liquid organic manures, medicinal properties, panchagavya, vermiwash, soil health

### Introduction

Bitter gourd (*Momordica charantia*; Family-Cucurbitaceae) is a herbaceous climbing annual with ridged stems that can reach up to 5 m long. It's leaves are a good source of calcium, iron, phosphorus, and vitamin B. Fruits contain polypeptide-P, vegetable insulin or charantin, which lowers blood sugar levels. The fruits and leaves contain guanylate cyclase inhibitor which impair chemical carcinogen induced increases in guanylate cyclase activity. Aside from its use as food, bitter gourd is sometimes used as an ornamental plant. In traditional medicine, ripe fruits are used to cure diabetes. The fruits are said to have anti-cancer properties, particularly against leukemia. Plant juices are used for the treatment of skin disorders, arthritis, rheumatism, asthma, cholera, diarrhoea, and alcohol dependency. The seeds of ripe fruits are used as condiment. The ripe seed coat is widely used to extract lycopene pigment; whereas the whole seeds are used for preparation of abortion inducing medicine. Roots are used as folk medicine for remedies of respiratory problems [1]. Today's production involves utilization of chemical fertilizers, pesticides and growth regulators for enhancing crop production. But, over dependence on chemical fertilizers adversely affects the soil and environment and also on humans. For sustainable production maintenance of soil health is prerequisite in intensive cultivation. The organic approach is one of the alternatives to conventional production system currently being advocated [2] considering the potential environmental benefits of organic production and its compatibility with integrated farming approaches, quality of food and sustainability, organic agriculture is considered as a viable alternative for sustainable agricultural development. [3] Now a days liquid organic manures are used in crop production to increase yield of organic crops as they are easy to prepare, good for most vegetables and applied while the crop is growing as topdressing. Required amount of organic matter and soluble nutrients are present in liquid organic manures compared to conventional organic manures which are helpful in maintaining soil health and sustainability [4, 5].

### Importance of Organic Bitter Gourd

#### Nutritional importance of bitter gourd

Bitter gourd contains considerable amount of water (83-92%), carbohydrates (4.0-10.5%), protein (1.5-2.0%), fat (0.2-1.0%), minerals (0.5-1.0%) and fiber (0.8-1.7 %). [6] Ripe fruits are rich in vitamin-A. Bitter gourd contains maximum amount of minerals and vitamins among all cucurbits. It is also exported due to its high keeping quality. Keseru *et al.* (2018) [7, 8] conducted experiments found several parameters like proteins, fibres, momordicine, charantin and vitamin C were made. The content of protein is higher in fruits of bitter gourd than in the fruits of common cucumber. The mineral content and vegetable fibre are higher in bitter gourd compared to other succulent vegetables. The bioactive compounds in mature leaves are present in the ratio of 2.5:1 for charantin and 2:1 for momordicine.

The highest content of vitamin C (197.12 mg 100<sup>-1</sup> dry substances) and total acidity (11.6%) was determined in the fruits of variants conducted with one branch and organically fertilized. Aparna *et al.* (2015) [9] conducted review studies and revealed that the fruit of bitter melon contains moisture (83.2%), proteins (2.9%), fat (1.0%), carbon (9.8%), fibers (1.7%), mineral matters (1.4%), calcium, phosphorus, iron, carotene, thiamine, nicotinic acid, riboflavin, ascorbic acid (88 mg 100<sup>-1</sup> g), copper and potassium.

#### Medicinal importance of bitter melon

Bitter melon has been used as a traditional medicine for diabetes (e.g., India, China, and Central America [10, 11] and other health-related ailments (e.g., health promoting substances such as charantin [11] and vicine [12] Bitter melon has been used as a folk remedy for tumors, asthma, skin infections, gastro intestinal problems, and hypertension. It has the benefit of reducing the diabetes mellitus by lowering the sugar levels in blood because of presence of three different groups of constituents. They are steroidal saponins known as charantin, insulin like peptides, and alkaloids. Bitter melon also helps in the treatment of digestive problems, like by stimulating appetite it improves digestion, by reducing the sugar levels in blood it helps in hypoglycaemic activity, which are all due to presence of several compounds. Every day intake of bitter melon juice has got several uses like boosting body stamina, treatment of constipation, treatment of hangover by detoxifying and nourishing liver, prevention of jaundice, chronic fatigue Behera *et al.* (2008) [13, 14] conducted studies and reported that the juice of bitter melon drawn directly from fruit has traditionally been used for medicinal purposes worldwide. Similarly, the extracted juice from leaf, fruit and even whole plant are routinely used for treatment of wounds, infections, parasites (e.g., worms), measles, hepatitis and fevers. Raman and Lau (1996) [15] studied anti-diabetic properties and phytochemistry of bitter melon and reported that unripe fruit, seeds and aerial parts have been used in various parts of the world to treat diabetes. Oral intake of the fruit juice or seed powder results in reduction of blood glucose and improves glucose tolerance in normal and diabetic animals and in humans. In bitter melon different types of compounds are separated like steroidal compounds and proteins but the active antidiabetic principle when orally administered was not noticed. P-insulin, a polypeptide, produces hypoglycaemic effects in humans and animals on subcutaneous injection, but oral activity is questionable. Charantin (fruit) sterol glucoside mixture and vicine (seed) pyrimidine nucleoside which are responsible for hypoglycaemic principle are reported. However these are only effective at doses too high to account for all the activity of the plant extract.

#### Advantages of organic bitter melon over chemically grown bitter melon

Most of the available market produce are developed by using conventionally grown bitter melon which are produced with excess amount of chemical fertilizers and pesticides which contain chemical residues. As a result most of juices contain toxic residues which are not good for human health. People are gradually realising the importance of bitter melon juice and other products developed from organically grown bitter melon. Therefore demand is increasing day by day for organic bitter melon.

#### Liquid organic manure as nutrient source of organic bitter melon

The present day organic bitter melon cultivation depends on bulky organic manure like farmyard manure, vermicompost and in some cases poultry manure. As these manures contain very low amount of plant nutrients and their mineralization rate is also very low. Therefore farmers are not getting desired yield from organic bitter melon cultivation. In recent days, liquid organic manures are getting relevance in organic cultivation. Foliar application of liquid organic manures absorbs nutrients 20 times faster than the applied through the soil. Temporary nutrient deficiencies can be overcome by using liquid organic manures. Whenever the nutrient uptake through the roots is stopped it stimulates growth by foliar application [16]. Liquid manure is prepared from farmyard manure or plant materials. Nutrient rich material is soaked in water for several days or weeks to undergo fermentation. Frequent stirring encourages microbial activity in liquid manures. The resulting liquid can either be used as a foliar fertilizer or applied to the soil. Liquid organic manures act as tonic or stimulant to plants. It is used as insecticide and fungicide. It improves the nutrient assimilation. Traditional organic formulations may contain numerous plant growth-promoting bacteria (PGPB), which may enhance plant growth by nitrogen fixation, growth hormone production and control phytopathogens [17, 18]. In many Asian countries, farmers formulate their own organic formulations by combining different organic materials and treating them by fermentation or composting. For example, in India, panchagavya (PG) is one of the widely used traditional organic formulations, which is mostly prepared by farmers themselves [17].

#### Advantages of liquid organic manure over bulky organic manure

**Benefits in Crop Productivity:** The growth of the crop is limited by saving labour cost required for removing the unwanted growth. It has the capacity to advance the crop maturity by 10 days. It improves the size, shelf life, texture and colour of the fruits. The plants are developed with sturdy plant growth, increased root growth and also offers pest and disease tolerance. As the liquid fertilizers are applied through foliar spray their uptake by the plants is very rapid due to the small particle size.

**Benefits in Soil relation:** The food material for microorganisms is given by the liquid organic manures by addition of organic matter to the soil. These organic matters serve as the building blocks for soil fertility enriched with humus. Liquid manures are rich in macro and micro nutrients and these are released slowly and consistently for continuous use by the plants. There is no damage of excess concentration of any nutrient as the material is broken by the microbes. Balanced nutrition is maintained due to the presence of trace elements in a huge manner. They also loosen the soil by opening the pores of the soil and microbes number will increase which release nutrients required by the crop. They do not affect the plants by burning due to salt concentration. Organic matter added by the liquid manures is long lasting and doesn't leach out as it binds to the soil particles. Liquid manures can easily be translocated from aerial parts of the plant to the soil.

**Socio-Economic benefits:** Liquid manures has no ill effect on human health as it does not show any toxicity. They are low cost preparation which improves socio-economic status of growers and farmers in the society. It is eco-friendly as it does

not throws any harmful residues into the environment or it does not cause any pollution due to leaching, runoff from irrigation water or downpour.

#### Available source of liquid organic manure for bitter gourd cultivation

Liquid organic manures like panchagavya, vermiwash, jeevamruth and beejamruth and other various types of organic solutions prepared from plant and animal origin are effective in the promotion of growth of crops. They are efficient plant growth stimulants and enhance the biological efficiency of crops and also activate biological reactions in the soil and to protect the plants from disease incidence. Panchagavya is a fermented liquid made by blending five ingredients obtained from cow, such as milk, urine, dung, curd and clarified butter. It has been using in Indian medicine since time immemorial in allelopathy, with deep conviction in ecological farming, sustainable agriculture, traditional knowledge and utilized to cultivate medicinal herbs. Vermiwash is another liquid organic manure that is collected after the passage of water through a column of worm action. It is a mixture of excretory products and mucus secretion of earthworms along with micronutrients from the soil organic molecules. Seaweed extract is rich in higher levels of organic matter, macro and micro nutrients which will benefit the various crops [19]. In addition it also contains growth regulators like cytokinins, auxins and abscisic acid which helps in promoting plant growth, yield and tolerance to pest and disease [20]. The mode of action of seaweed extract is still not known but the usefulness of its application is due to different components present in it may affect synergistically together at different concentrations [21, 22]. Humic acid is like a plant growth hormone which has the capacity to increase plant growth and uptake of several nutrients and improves tolerance to stress conditions [23]. It is not only beneficial to shoot and root growth but also nutrient uptake of vegetable crops [24]. Foliar sprays of humic substances also promote growth in a number of plant species [25]. Liquid organic manures promote immense biological activity in soil and enhance nutrient availability to crop. Some liquid manures protect the crop from soil borne and seed borne pathogens and also improves seed germination [26]. Spraying of panchagavya facilitate instant uptake of nutrients which led to increased growth there by influencing the total dry matter production in *Moringa* [27]. Application of vermicompost with foliar application of 3% panchagavya enhanced the yield of *Amaranthus* cv. CO3 [28].

#### Impact of liquid organic manure on growth and yield of bitter gourd

Sangeetha *et al.* (2018) [29] conducted an experiment in bitter gourd and revealed that the application of vermicompost at 4.68 t ha<sup>-1</sup> recorded maximum yield of fruits per vine (3.99 kg) with an average fruit weight of (62.18g) followed by inorganic fertilizers NPK at 100:60:50 kg ha<sup>-1</sup> recorded fruit yield/vine (3.64 kg) and with average fruit weight (56.75g) Muhammad *et al.* (2015) [30] conducted an experiment to evaluate the effect of different organic materials on bitter gourd. The results revealed that the poultry manure produced the highest yield among the organic materials. During the year 2010, 2011 and 2012 poultry manure gave the highest yield (5.77 t ha<sup>-1</sup>, 6.92 t ha<sup>-1</sup> and 7.56 t ha<sup>-1</sup> respectively). Benitez *et al.* (2013) [31] carried out an experiment on Bitter gourd cv. Makiling. Bitter gourd was grown in soil amended with organic fertilizers, namely, Bio-N, commercial compost and vermicompost, at the rate of 0.075 g seed<sup>-1</sup>, 150 g plant<sup>-1</sup> and

231 g plant<sup>-1</sup>, respectively. The results revealed that all the vegetative growth and herbage yield of bitter gourd were significantly increased by the application of different organic fertilizers. Compare to the control, the total herbage yield was improved by 30%–40% when vermicompost, Bio-N and commercial compost were applied to the plants. The promotion of vine growth of bitter gourd, brought about by organic fertilizers, was comparable to that as a result of applying inorganic fertilizer. Organically grown plants advances flowering by 1-2 week *i.e.*, 45-52 days after emergence of seedling compared to control. The least number and the smallest fruits were harvested from unfertilized bitter gourd plants while the highest number of fruits was collected from plants fertilized inorganically. The latter treatment, however, yielded the highest number of both marketable and non-marketable fruits. Fruit yield and yield components of bitter gourd treated with organic fertilizers were similar to those of plants treated with inorganic fertilizer, except for the total number and the weight of fruits. Out of the three organic fertilizers tried, by application of commercial compost resulted in the greatest improvement in both vegetative and reproductive growth as well as in the total herbage and fruit yield of bitter gourd. Anuja and Archana (2012) [32] conducted an experiment to study the effect of organic nutrient on yield of bitter gourd. They applied organic manure alone and their combination with and without liquid manure to the crop. They observed that all the organic treatments proved to be superior to the control with yield. Application of FYM at 25 t ha<sup>-1</sup> + vermicompost at 5 t ha<sup>-1</sup> + panchagavya at 3% recorded highest fruit yield per vine *i.e.*, 1489 g in season-I and 1616 g in season-II. Anuja and Archana (2011) [33] carried out an investigation to find out the effect of soil and foliar application of organic nutrients on flowering, fruit set percentage and fruit maturity of bitter gourd cv. Long Green. Results of the experiment revealed that the application of FYM at 25 t ha<sup>-1</sup> and vermicompost at 5 t ha<sup>-1</sup> along with panchagavya 3 per cent foliar spray improved the number of female flowers (5.02), fruit set (79.86 %) percentage and early maturity of fruits (13.42 days) of bitter gourd in both the seasons. Anuja and Poovizhi (2010) [34] conducted field experiment on effect of soil and foliar application of organic nutrients on yield and quality of cucumber cv. Long Green and concluded that the application of (farmyard manure at 12.5 t ha<sup>-1</sup> + vermicompost at 2.5 t ha<sup>-1</sup> + panchagavya 3%) registered the maximum yield of cucumber. Meerabai *et al.* (2007) [35] conducted experiment on bitter gourd and results revealed that among the various organic nutrient sources, poultry manure was found best in increasing the number of harvests, number of fruits plant<sup>-1</sup>, total fruit yield, net returns. The fruit yield produced by poultry manure was 46.5% higher as compared to control-1. Mulani *et al.* (2007) [36] conducted an experiment on bitter gourd and the findings revealed that the application of 25% nitrogen through neem cake and 75% through poultry manure was found best in the enhancement of the growth, yield and quality parameters of bitter gourd like average vine length (5.38 m), fruit weight (84.80 g), fruit length (26.94 cm), fruit girth (3.48 cm), pulp thickness (1.03 cm), number of fruits per vine (63.11), fruit yield (263.33 kg ha<sup>-1</sup>) and shelf life (7.33 days).

#### Impact of liquid organic manure on quality and post-harvest shelf life of bitter gourd

Sangeetha *et al.* (2018) [29] conducted experiment in bitter gourd and the results revealed that the application of vermicompost at 4.68 t ha<sup>-1</sup> recorded maximum quality

attributes like TSS (5.68 °Brix), Zn (47.69 ppm) and Fe (0.15 %) content of the fruit were significantly influenced with the application of vermicompost while vitamin C and Fe were significantly affected with the application of both organic and inorganic fertilizers in different combinations. Muhammad *et al.* (2015) <sup>[30]</sup> conducted an experiment on quality of bitter gourd. The results revealed that in the year 2010 poultry manure recorded highest quality parameters like dry matter (8.56%), (1.74%), crude fat (2.01%), crude fiber (1.74%) and mineral matter (1.06%) while during 2011 also, it gave highest dry matter (8.84%), crude protein (1.59%), crude fat (2.06%), crude fiber (1.55%) and mineral matter (1.65%) and in the year 2012 also, it gave highest dry matter (8.72%), crude protein (1.88%), crude fiber (1.54%), crude fat (2.26%) and mineral matter (1.24%). Benitez *et al.* (2013) <sup>[31]</sup> studied Bitter gourd cv. Makiling which was grown in soil amended with organic fertilizers, namely, Bio-N, commercial compost and vermicompost, at the rate of 0.075 g seed<sup>-1</sup>, 150 g plant<sup>-1</sup> and 231 g plant<sup>-1</sup>, respectively. They observed that organically grown bitter gourd produced higher amount of antioxidants in leaves and fruits than the chemically fertilized plants. Anuja and Archana (2012) <sup>[32]</sup> conducted an experiment on quality of bitter gourd. They revealed that among the organic treatments, application of FYM at 25 t ha<sup>-1</sup> + vermicompost at 5 t ha<sup>-1</sup> + panchagavya at 3% recorded significantly higher TSS and ascorbic acid content in the fruit. Anuja and Poovizhi (2010) <sup>[34]</sup> studied the effect of soil and foliar application of organic nutrients on yield and quality of cucumber cv. Long Green. They reported that the application of FYM at 25 t/ha recorded maximum total soluble solids (3.93 and 4.96 °Brix) and ascorbic acid content (8.28 and 8.55 mg 100g<sup>-1</sup>), (8.29 and 8.49 mg 100g<sup>-1</sup>) in both tender and matured fruits. Meerabai *et al.* (2007) <sup>[35]</sup> conducted experiment on bitter gourd and reported that the keeping quality was best when vermicompost was applied as the organic source. *Azospirillum* significantly improved the quality of bitter gourd fruits like vitamin C and protein content. Mulani *et al.* (2004) <sup>[36]</sup> conducted an experiment to study the effects of organic manures and biofertilizers on the growth, yield and quality of bitter gourd and found that the application of 25% nitrogen through neem cake and 75% through poultry manure was superior in the enhancement of the quality parameters of bitter gourd *i.e.*, pulp thickness (1.03 cm) and shelf life (7.33 days). Rajasree *et al.* (2004) <sup>[37]</sup> conducted study on fruit quality and shelf life of bitter gourd using poultry manure as an organic source. Three levels of nitrogen (200, 250 and 300 kg N ha<sup>-1</sup>) were applied in three ratios of organic-chemical N substitutions (1:1, 1:2, 2:1) at three different frequencies of application. Results reported that the greater proportion of organic source of nutrients from poultry manure enhanced the shelf life of fruits.

#### Future research scope of liquid organic manures

Liquid organic manures are gaining popularity among the organic growers of the country. However, adoption rate is much lower than the expected. Now to promote liquid organic manure as a nutrient component of organic crop the following research works is urgently required.

- Apart from farmyard manure and vermicompost, the performance of other organic manures like poultry manure, neem cake, compost and Biodynamic preparations (BD) may be evaluated along with different liquid organic manures for organic bitter gourd cultivation.

- Apart from *Azotobacter* enrichment, other microbial inoculants like VAM (Vesicular Arbuscular Mycorrhiza), *Azospirillum*, PGPR (Plant Growth Promoting Rhizobacteria) may be selected for enrichment of organic manures and evaluated their potential as nutrient source of bitter gourd.
- Studies to minimize the cost of cultivation which is beyond the reach of farmer, low cost organic inputs beneficial to soil health and crop productivity need to be evaluated and promoted.
- On farm traditional formulations like Panchgavya, Jivamrit, Vermiwash, Amritpani, cow urine, neem seed kernel extract, garlic, ginger, chilli extract and Banyan tree soil should be evaluated alone or in two or three combination for organic bitter gourd cultivation.
- Studies on combined effect of bulky organic, bio-fertilizers and liquid organic manures can be taken up in other important cucurbits.
- Study on influence of organic nutrient sources and liquid organic manures on soil physical, chemical and biological properties in long run may be carried out for the region.

#### Conclusions

Different review studies suggest that liquid organic manures has beneficial effect on growth, yield and quality of organic bitter gourd. To promote low cost organic bitter gourd cultivation use of liquid organic manure should be encouraged. The practice will not only increase the yield of organic bitter gourd but also improve the fruit quality and enhance the shelf life of the fruits, simultaneously it will make the production system more sustainable in long run. Home scale preparation of different liquid manure and their application should be promoted among the organic growers for large scale adoption of organic bitter gourd cultivation.

#### Conflict of interest

No conflict of interest declared

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