Significance of Liquid Organic Manures in Indian Agriculture –A Review

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INTRODUCTION

Use of agro-chemicals in agriculture has weakened the ecological base in addition to degradation of soil, water resources and quality of the food. Awareness has to be created on the adoption of organic farming as a remedy to makeover the ill effects from modern chemical farming (Kannaiyan, 2000). Enough organic sources like; legume-based crop rotations with BNF, non-symbiotic nitrogen fixation, crop residues, composts, green manures, animal dung and urine, plant based nutrients, nutrient transformations, mineralization of nutrients etc, are the greater options available with us on the farm to replace with the demand of chemical fertilizers up to some extent in organic farming. The proper management of these make it possible to increase the efficiency of soil and added nutrients. Now, it is essential to develop a strong workable, feasible and compatible package of nutrient management through organic resources for various crops based on scientific facts, local conditions and economic viability. The use of fermented liquid organic manures, effective microorganisms and fermented plant extracts as foliar fertilizers have been introduced to modern agriculture in recent years to produce food with good quality and safely (Galindo et al., 2007). Liquid manure is often regarded as the best among manures. Organic composts and other solid manures are great but they have one drawback over conventional soluble manures that they take a break down in the soil and become available to plants. So, for the successful growing of heavy feeding crops the judicious use of liquid manures has an effective tool and can be applied to all crops such as pulses, oilseeds, rice, sugarcane, vegetables, fruits, flowers, etc. Use of fermented curd, rich in beneficial microorganisms, is also practiced elsewhere both to augment plant growth and suppress pest load on crop plants. Of late, use of fermented cow dung, urine, milk fat, curd and milk with the name of Panchagavya is getting adaptive popularity in Indian agriculture largely through the efforts of small groups of farmers. Role of foliar applied Panchagavya in production of many plantation crops had been well documented in India (Selvaraj, 2003). Panchagavya, an organic input, can act as a growth promoter and immunity booster. Panchagavya was the most cost-effective growth promoter for small and marginally profitable vegetable crop growers (Bindumathi, 2008). Its role as plant growth promoter has already been reported by Subhashini et al. (2001) and Sreenivasa et al. (2009). Foliar spray of Panchagavya + neem leaf extracts registered significant improvement in chlorophyll content, nitrate, reductase activity, root nodule weight, dry matter accumulation, nutrient content and uptake, yield attributes and yield of groundnut when compared with control and Panchagavya alone (Kumawat et al., 2009).

Liquid manures in Indian Scenario- Panchagavya acts both as fertilizer and biopesticide (Anonymous, 2005a). Nene (1999) reported that cow's ghee had been used in ancient and medieval times (Kautilya 321-296 BC and Someshwara Deve 1126 AD) for managing seedling health. The ghee contains vitamin A, Vitamin B, Calcium, fat and also glycosides, which protects cut wounds from infection. Cows curd is rich in microbes (Lactobacillus) that are responsible for fermentation (Chandha, 1996). Pathak and Ram (2002) reported that Rishi Krishi, a system of traditional agriculture practiced in Maharashtra is using Amrit pani (prepared by mixing 20 kg cow dung, 0.125 kg butter, 0.50 kg honey, 0.25 kg ghee) and kept overnight to treat seeds and for spraying on field crops to maintain soil fertility and crop yield.

Panchagavya- It is a promising natural liquid manure is being used by many organic farmers in many agricultural and horticultural crops in different parts of our country (Anonymous, 2005 b). Panchagavya has got reference in the scripts of Vedas (divine scripts of Indian wisdom) and Vrkshayurveda (Vrksha means plant and ayurveda means health system). The texts on Vrkshayurveda as systematization of the practices that the farmers followed at field level, placed in a theoretical frame work and it defined certain plant growth stimulants, among them Panchagavya was an important one that enhanced the biological efficiency of crop plants and quality of fruits and vegetables (Natarajan, 2002). In Sanskrit, Panchagavya means a combination of five products obtained from cow viz., cow dung, cow urine, cow milk, cow ghee and cow curd. Panchagavya has the potential to play the role of promoting growth and providing immunity in plant system. Panchagavya was tested for different crops such as turmeric, paddy, onion, gingely, 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). Panchagavya is used in different means such as foliar spray, soil application along with irrigation water, seed or seedling treatment etc. For foliar spray, 3% concentration is being adopted by organic farmers using hand-operated sprayers with high pore sized nozzle (Natarajan, 2002).

Physico-chemical and biological properties of fermented liquid manures- The nutrient status and microbial load present in Panchagavya, Jeevamrutha, Beejamrutha and Bio-digester are analysed by many scientists/institutes. Presence of naturally occurring beneficial microorganisms predominantly bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi were detected in organic liquid manures (Swaminathan, 2005).

Panchagavya- It contained Pseudomonas (45 x 103 cfu/ml) and saprophytic yeasts (35 x 104 cfu/ml) which might have contributed to plant protection because Pseudomonas on plant surfaces have been found to induce pathogenesis related protein, siderophores, antibiotics and HCN in groundnut and rice thus, enabled its use as a bio-controlling agent (Meena et al., 2000). Swaminathan et al. (2007) reported that Panchagavya is a fermented liquid of 5 main ingredients viz., cow dung, cow urine, cow's milk, ghee and curd and this ultimate product had total N (302 g/kg), total P (219 mg/kg), total K (355 mg/kg), total organic carbon (0.80%), bacteria (34 x 106 cfu/ml), fungi (22 x 104 cfu/ml), Actinomycetes (3 x 102 cfu/ml), Zn (0.26 mg/kg), Fe (0.83 mg/kg), Mn (0.23 mg/kg), Cu (0.20 mg/kg), pH of 6.02 and electrical conductivity 3.02 dS/m. Sreenivasa et al. (2011) reported that Panchagavya had pH 6.8, soluble salt 1.88 ds/m, total nitrogen 0.1%, total phosphorus 175.4 ppm, total potassium 194.1 ppm, total zinc 1.27 ppm, total copper 0.38 ppm, total iron 29.71 ppm, total manganese 1.84 ppm, bacteria (26.1 x 105 cfu/ml), fungi (18 x 104 cfu/ml), Actinomycetes (4.2 x 103 cfu/ml), Phosphate solubilising organisms (5.7 x 102 cfu/ml) and free living N2-fixers (2.7 x 102 cfu/ml).

Presence of naturally occurring, beneficial, effective microorganisms in Panchagavya predominantly, lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi besides beneficial and proven fertilizers such as Azetobacter, Azospirillum and Phosphobacterium were detected which have the beneficial effect especially in improving soil quality, growth and yield of crops (Xu and Xu, 2000 and Papen et al. (2002).

Jeevamruta- It is a fermented liquid product prepared by mixing up cow dung (10 kg) with cow urine (10 litre), jaggery (2 kg), legume flour (2 kg) and handful of soil brought from the bunds of the lands where cultivation is to be taken up (Palekar, 2006) and kept for one-week incubation. Jeevamruta also contains enormous amount of microbial load which multiply and act as a soil tonic. It is said to enhance microbial activity in soil and ultimately ensuring the availability and uptake of nutrients by the crops. Sreenivasa et al. (2011) reported that Jeevamruta had pH 7.07, soluble salt 3.40 ds/m, total nitrogen 770 ppm, total phosphorus 166 ppm, total potassium 126 ppm, total zinc 4.29 ppm, total copper 1.58 ppm, total iron 282 ppm, total manganese 10.7 ppm, bacteria (20.4 x 105 cfu/ml), fungi (13.8 x 104 cfu/ml), Actinomycetes (3.6 x 103 cfu/ml), Phosphate solubilising organisms (4.5 x 102 cfu/ml) and free living N2-fixers (5 x 102 cfu/ml).

Beejamruta- It was prepared using the different ingredients cow dung, cow urine, water and lime. Cow dung (5 kg) tied in a cloth was dipped in a bucket containing 50 liters of water overnight. Next day morning, the tied dung was frequently squeezed and dipped in the water. Five litres of cow urine, a handful of soil and 50 g of calcium chloride was added to this extract. Sreenivasa et al. (2011) reported that Beejamrutha had pH 8.2, soluble salt 5.5 ds/m, total nitrogen 40 ppm, total phosphorus 155.3 ppm, total potassium 252 ppm, total zinc 2.96 ppm, total copper 0.52 ppm, total iron 15.35 ppm, total manganese 3.32 ppm, bacteria (15.4 x 105 cfu/ml), fungi (10.5 x 104 cfu/ml), Actinomycetes (6.8 x 103 cfu/ml), Phosphate solubilising organisms (2.7 x 102 cfu/ml) and free living N2-fixers (3.1 x 102 cfu/ml).

Bio-digester- Bio-digester was prepared by adding botanical plants mainly neem, calotropis, vitex, lantana, adothoda, ipomea, custard apple and agave (5 kg each) to the bio-digester tank containing urine (10 litres), dung (10 kg), little quantity of soil and 200 litres of water. The digested liquid manure was ready in 3 weeks. Sreenivasa et al. (2011) reported that Bio-digester had pH 7.29, soluble salt 1.09 ds/m, total nitrogen 255 ppm, total phosphorus 79 ppm, total potassium 42 ppm, total zinc 0.52 ppm, total copper 1.24 ppm, total iron 9.6 ppm, total manganese 8.3 ppm, bacteria (12.9 x 105 cfu/ml), fungi (9.2 x 104 cfu/ml), Actinomycetes (3 x 103 cfu/ml), Phosphate solubilising organisms (1 x 102 cfu/ml) and free living N2-fixers (2.1 x 102 cfu/ml).

Effect of liquid manures on growth and yield- Effect of Panchagavya on germination and growth of spinach (Tetragonia tetragonoides) in showed that Panchagavya foliar spray on 10th, 20th, 30th, 40th and 50th DAP alone gave 18% higher yield over the conventional method (Natarajan, 1999). Balasubramanian et al. (2001) reported that dipping of rice seedlings in Panchagavya solution before transplanting enhanced the growth and yield. Oparaeke et al. (2001) recorded more pod intensity per plant with application of neem leaf extract in cowpea. Increased yield with Panchagavya application due to augmentation in the biological efficiency of crop plants was observed by Natarajan (2002). Selvaraj (2003) also reported 36% increase in yield of French bean with application of vermicompost + Panchagavya. Increase in yield of sunflower, maize and green gram was also observed with Panchagavya spray (Somasundaram, 2003). Louduraj et al. (2005) observed that Panchagavya @ 3% spray 4 times for okra augmented the yield level in treatment

receiving poultry manure over the control. Similarly, Panchagavya applied @ 3% spray at 0, 30, 50 days after planting in rice crop recorded significantly higher grain yield over no Panchagavya spray (Ramanathan, 2006). Increase of 7-11% in grain length, 100-grain weight, grain and stover yield of rice with the foliar spray of Panchagavya was reported by Yadav and Louduraj (2006). They had also reported higher tillers per hill in rice with Panchagavya spray. All growth parameters, yield attributes and yield of soybean were recorded significantly higher under the plots receiving organic manures in combination with fermented liquid manures viz., Beejamruta, Jeevamruta, Panchagavya over organic manures alone (Shwetha and Babalad, 2007). Increased number of leaves/plant of ashwagandha was recorded with the application of Panchagavya (3%) solution by Mohanalakshmi and Vadivel (2008). Chandrakala (2008) observed higher dry chilli yield over the control with combined application of Beejamruta + Jeevamruta + Panchagavya and spray of Panchagavya alone plots. Growth, nutrient uptake, yield and andrographolide content in kalmegh (Andrographis paniculata) were appreciably improved with the application of farmyard manure and Panchagavya spray in conjunction (Sanjutha et al., 2008). Two sprays of Panchagavya at 30 days after sowing and flowering stage in sesame recorded higher seed yield by 3.2% over the control (Ravusaheb, 2008).

Amazing development in consumptive use of water, water use efficiency, yield and yield attributes of maize was recorded due to green manure incorporation and foliar spray of Panchagavya twice in the standing crop (Meena et al., 2009). Higher number of seed sized tubers and the yield of potato tubers were registered with spraying of Panchagavya at 15 days' interval in the fields and soaking the tubers in 3% Panchagavya solution before storage over the control by Ravichandran et al. (2011). Three foliar sprays of Panchagavya (3%) and soil application of Jeevamruta brought significant improvement in growth and yield parameters as well as yield of greengram resulted in 15.6 and 14.4% increase in grain yield over the control, respectively (Yadav and Tripathi, 2012). Soil application of Panchagavya solution (3 l/m2) significantly enhanced pod and haulm yield of groundnut to the tune of 85.3 and 93.2%, respectively, over the control (Kumawat et al., 2013). The possible reason might be due to that the application of organic sources of nutrients as foliar spray would have induced the endogenous synthesis of native auxins resulting in active growth. Moreover, the interaction with the synthesis of native cytokinins in the root cells and its transport at later stages to axilary buds, led to formation of more growth. The other possible explanation might be due to the favourable effects of IAA, GA3, major and micronutrients and also microorganisms present in these liquid manures (Somasundaram, 2003). Similarly, the beneficial effects of Jeevamruta reported by Palekar (2006) and Vasanthkumar (2006) was attributed to huge quantity of microbial load and growth hormones which might have enhanced the soil biomass, thereby sustaining the availability and uptake of applied as well as native soil nutrients which ultimately resulted in growth and yield of crops.

Effect of Panchagavya blended with leaf extracts on growth and yield- Three foliar sprays of Panchagavya (3%) + neem leaf extracts (1:1) brought significant improvement in growth and yield parameters as well as yield of greengram resulted in 10.5 and 27.7% increase in grain yield over Panchagavya alone and the control, respectively and this might be owing to presence of growth promoting substances in Panchagavya might have produced a positive effect on physiological growth of the crop and in turn helped in increased yield attributes and yield of greengram (Yadav and Tripathi, 2012). Kumawat et al. (2013) reported that foliar spray of Panchagavya in combination with datura (Datura metel) leaf extract at 1:1 ratio enhanced pod yield of groundnut significantly over the control.

Effect of liquid manures on quality parameters- Quality parameters such as crude fibres, protein, ascorbic acid, carotene content and shelf life of annual moringa (Moringa oleifera Lam.) were found higher in organic manure applied with Panchagavya spray (Beaulah et al., 2002). Yadav and Lourduraj (2006) revealed that foliar spray of Panchagavya and organic manures recorded better cooking qualities and physical characteristics of rice as well as higher sensory score as compared to recommended N, P and K through fertilizers. Vennila and Jayanthi (2008) revealed that application of 100% recommended dose of fertilizer combined with 2% foliar spray of Panchagavya in okra resulted in higher crude protein, ascorbic acid and Barletts index. Concentrations of ascorbic acid, total soluble solids, oleoresin, capsaicin and capsanthin in paprika (Capsicum annuum var. Longum) were increased due to application of Panchagavya @ 4% (Kumar et al., 2008). Combined application of Beejamruta + Jeevamruta + Panchagavya and spray of Panchagavya alone had higher ascorbic acid, oleoresin and colour value in chilli over the control (Chandrakala, 2008). Ravi Kumar et al. (2011) reported that quality parameters like protein and oil content as well as protein yield were recorded significantly higher with the application of FYM (7.5 t/ha) + Rhizobium + PSB + Panchagavya (3% at 30, 60 and 75 DAS) as compared to other integrated organic treatments.

Effect of liquid manures on soil properties- Pathak and Ram (2002) observed that Rishi krishi, a system of agriculture practice in Maharashtra uses Amrit Pani (prepared by mixing 20 kg cow dung, 0.125 kg butter, 0.5 honey, 0.25 kg ghee) and kept overnight to treat seeds and for spraying on field crops to maintain soil fertility and crop yield. Application of liquid organics such as organic booster @ 1 litre/m2, cow dung urine slurry @ 1 litre/m2 along with vermicompost @ 5 t/ha recorded higher organic carbon content than the recommended dose of fertilizer; whereas, the pH and EC were decreased after harvest of chilli compared to initial values (Hangarge et al., 2004).

Shwetha and Babalad (2007) reported that soil properties viz., organic carbon and available soil nutrients (N, P2O5 and K2O) after harvest of soybean and wheat crops were significantly higher with organic manures alone or in combination with fermented organics viz., Beejamruta + Jeevamruta + Panchagavya; however, microbial and enzymatic activity was significantly higher in same treatments. Poyyamoli (2008) reported that the combined application of FYM @ 12.5 t/ha along with Panchagavya and Amutha karaisal registered highest amount of available macronutrient and K, higher exchangeable K, exchangeable Ca, exchangeable Mg and lower exchangeable Na and ESP at post-harvest of rice. Ravusaheb (2008) reported that two sprays of Panchagavya at 30 DAS and flowering stage recorded higher microbial population and available N, P2O5 and K2O content in the soil.

Influence of Panchagavya on soil fertility- Microbial flora of soil plays an important role in soil health. The microorganisms present in the rhizospheres environment around the roots affect the plant growth and crop yield. The beneficial microorganisms from Panchagavya and their establishment in the soil improved the sustainability of agriculture. Kumawat et al. (2013) suggested that soil application of Panchagavya may possibly be recommended for yield improvement in a high pH soil as it helped in temporarily moderation of undesirable soil chemical properties. Further they reported that soil application of Panchagavya solution (3 l/m2) significantly decreased the soil pH from 9.0 to 8.3 during initial 5 days' period, whereas it increased soil organic carbon content by 50% and availability of P, Fe, Cu, Zn and Mn in the rhizosphere by 17%.

CONCLUSION

Plant growth substances present in fermented liquid manures help to bring rapid changes in phenotypes of plants and also improves the growth and ultimately enhance the productivity of the crops. The microorganisms present in soil rhizospheres environments around the roots affect the plant growth and crop yield. The beneficial microorganisms found in liquid manures and develop in the soil enhance the sustainability of organic and natural farming of agricultural and horticultural crops.

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