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Influence of liquid organic manures on growth, yield and quality of mulberry leaves and rearing performance of silkworm (*Bombyx mori* L.)

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Abstract
Sericulture is a low input, income generating occupation and highly suited to rural and semi urban areas. India's traditional and culture-bound internal market, as well as an amazing divergence of silk garments that reflect geographic specificity, have aided the country to reach the top of the seri-enterprise world, producing all the five types of commercial silks, *viz*., Mulberry, Tropical Tasar, Oak Tasar, Eri and Muga. Liquid organic manures can encourage low-cost organic farming and enhance crop yields and soil quality. They can also increase bio-efficacy of plants and supply them with nutrients. Since the sericulture industry uses mulberry, it is essential to increase its growth, yield and leaf quality in order to obtain high-quality cocoons. This review study brought together some of the studies that have been conducted on the impact of liquid organic manures on the soil and other crops.

Keywords: Mulberry leaves, organic manures, rearing performance

Introduction
Sericulture is a low input, income generating occupation and highly suited to rural and semi urban areas. India's traditional and culture-bound internal market, as well as an amazing divergence of silk garments that reflect geographic specificity, have aided the country to reach the top of the seri-enterprise world, producing all the five types of commercial silks, *viz*., Mulberry, Tropical Tasar, Oak Tasar, Eri and Muga.

Silkworm rearing can generate huge amount of waste in the form of silkworm faeces and left over leaves which is creating environmental issues. It was examined that by rearing 100 DFLs by consuming 1000 kg of mulberry leaves generates approximately 300 kg of litter and 500 kg of left over mulberry waste comprising of withered leaves, leaf veins, leaf stalks *etc*. Sericulture waste has been used as a growing medium for mushrooms and as a source of biogas due to its abundance, mostly in sericulture areas. It was suggested that it can be used for composting other plant leftovers in order to produce organic manures and vermicompost (Sakthivel *et al*., 2014) [46].

The very nature of seri enterprise is a rural-based on-farm and off-farm activities clubbed with enormous employment and income generation potentials, makes it as one of the most appropriate tools to improve socio-economic status of India. The high population density is exerting a demand on the use of natural resources. (Bui Xuan and Preston, 1999) [10]. Increased depletion of soil fertility is caused due to indiscriminate use of chemical fertilizers and pesticides. Adoption of an integrated farming system that uses minimal external inputs and waste recycling is one option to solve the problem (Preston and Leng, 1989) [38].

Traditionally organic farming is native to Indian agriculture, before dawn of the green revolution where crops and livestock have been reared together in all the farm households. As of now, more than 85% of the farm-households field crops and livestock farming system is prevailing. According to the National Institute of Agricultural Economics and Policy Research's, Total Factor Productivity (TFP) growth score, technology-driven growth was highest in Punjab and lowest in Himachal Pradesh. It means that several states in India, such as Himachal Pradesh, Uttarakhand, Madhya Pradesh, Rajasthan, Jharkhand, and the North-Eastern area, have been

relatively unaffected by the use of chemical fertilizers and pesticides in agriculture. Furthermore, despite of all technological developments, nutrient utilization efficiency is on the decline (33% for N, 15% for P and 20% for K and micronutrients). On the other hand, it has been scientifically and conclusively demonstrated that the use of organic manures in combination with chemical fertilizers will improve nutrient efficiency by improving the soil physical, chemical, and biological properties at the same time. The use of organic manures on a regular and consistent basis improves the soil water holding capacity. It is estimated that various organic resources having the total nutrient potential of 32.41 million tonnes will be available for use in 2025. Out of these organic resources, considerable tappable potential of nutrients ($N + P_2O_5 + K_2O$) from human excreta, livestock dung and crop residue which accounts to be 7.75 million tonnes (Ravisankar *et al*., 2017) [45].

Organic manures play major role in soil health by improving its physical, chemical and biological properties. It enhances water holding capacity in sandy soils, facilitates aeration and infiltration in heavy soils, increases nutrient supply power of alkaline soil by reducing its pH, promotes the activities of beneficial microorganisms to build up the soil fertility besides its own nutrient values. The buffering character of the organic matter is considered to be advantageous to overcome the problem of residues of pesticides, fungicides, herbicide and other heavy metals in agro-ecosystem.

Though chemical farming has positive results at first, the sericulture farmers soon notice the negative effects on mulberry leaf yield as well as quality and cocoon productivity. Hence, practice of organic farming is need of the hour in sericulture to avoid indiscriminate use of chemicals in mulberry garden. In this context, this bulletin enumerates possible organic inputs and their utility in mulberry farming as well as recent advancements in eco-friendly agronomical package of practices developed for sustainable sericulture.

As per the National Silk Policy-2020 it is suggested that the Central Silk Board promotes organic certification of farm produce and silk products through authorized agencies like the Global Organic Textile Standard (GOTS).

Apart from using conventional farm-based products, there is a growing demand for improvised materials such as jeevamrutha, panchagavya, amritpani, bio-digested liquid organic manures, sasyagavya, kunapajala, vermiwash, fish amino acids, fermented plant juices, and other improvised materials that primarily enrich the soil with indigenous microorganisms. Jeevamrutha is a low-cost improvised preparation that enriches the soil with indigenous microorganisms that are necessary for soil mineralization (Gore and Sreenivasa, 2011) [21]. Organic liquid formulations such as jeevamrutha and panchagavya aid in the rapid development of soil fertility by increasing the activity of soil microflora and fauna (Devakumar *et al*., 2014) [16]. These act as both a fertilizer and a biopesticide, and they serve an important function in encouraging plant growth and providing immunity.

Farm yard manure has been used to fertilize crops since the dawn of time. In addition to providing plant nutrients, well-decomposed and fermented farm yard manure works as a binding element and improves the physical, chemical, and biological characteristics of the soil. Bio-digester liquid fluids, on the other hand, will boost microbial populations such as nitrogen fixers, phosphorus solubilizing bacteria, and actinomycetes. As a result, the ability of farm yard manure and bio-digester liquids to deliver nutrients and increase beneficial bacteria for faster decomposition has become extensively acknowledged in agriculture in recent years.

1. Influence of liquid organic manures on soil properties

Ansari and Sukhraj (2010) [5] studied effect of vermiwash and vermicompost on soil parameters and productivity of okra (*Abelmoschus esculentus*). The study revealed that combination treatment of vermiwash and vermicompost was found to be better suggesting qualitative improvement in the physical and chemical properties of the soil. The maximum increase in organic carbon, available nitrogen, magnesium and calcium percentage was observed in vermiwash and vermicompost, followed by vermicompost and cattle dung.

Ali *et al*. (2011) [1] studied the effect of panchagavya and Sanjibani on soil health. The pH and EC become close to neutral (pHfrom 6.80 to 7.00 and ECfrom 0.20 to 0.30 mmhos/cm). The organic carbon increased to 1.10% from 0.71%. Available Phosphate and Potash has increased to greater extent (P - more than 3 times and K - more than 2 times).

Lavanya *et al*. (2016) [28] revealed that maximum population of general bacteria, fungi, actinomycetes, N-fixers, *Pseudomonas* and PSB were observed to be 40×10^5 cfu g^{-1}, 32×10^3 cfu g^{-1}, 15×10^4 cfu g^{-1}, 21×10^5 cfu g^{-1}, 3×10^5 cfu g^{-1} and 25×10^5 cfu g^{-1}, respectively in the soil treated with jeevamrutha at 400 l $acre^{-1}$ and 7.50% panchagavya in field bean when compared to without jeevamrutha and panchagavyatreated soil (5×10^5 cfu g^{-1}, 3×10^4 cfu g^{-1}, 8×10^3 cfu g^{-1}, 10×10^5 cfu g^{-1}, 1×10^5 cfu g^{-1} and 10×10^5 cfu g^{-1} general bacteria, fungi, actinomycetes, N-fixers, *Pseudomonas* and PSB, respectively).

Perminder (2017) [37] studied the effect of organic management practices on soil properties under capsicum (*Capsicum annuum* L.). The results revealed that the application of PGPR + 90% RDN + panchagavya (5%) + jeevamrutha (5%) + amritpani significantly improved available soil nutrients i.e., available N (443.53 kg ha^{-1}), available P (77.26 kg ha^{-1}) and available K (293.40 kg ha^{-1}) and micronutrient cations. The conjoint application of PGPR along with bulky manures and organic liquid inputs (like panchagavya, jeevamrutha and amritpani) may be recommended for increasing the yield of capsicum and sustaining soil health.

Chaithra (2018) [13] studied the effect of farm yard manure and jeevamrutha on growth and yield of Sunflower (*Helianthus annuus* L.).The results revealed that soil fertility status improved with higher available nitrogen (354.57 kg ha^{-1}), phosphorus (52.48 kg ha^{-1}) and potassium (260.78 kg ha^{-1}) contents with application of farm yard manure at 150% N equivalent andjeevamrutha at 1500 litres ha^{-1}. Further, significantly higher bacteria, fungi, actinomycetes, P-solubilizers and N-fixers population were recorded with application of farm yard manure at 150% N equivalent and jeevamrutha at 1500litresha^{-1}.

A field experiment was conducted to study the physical-chemical properties of mulberry field soil as influenced by the application of seri waste digester liquid to V-1 mulberry garden. The study revealed that application of 50 percent seri bio-digester effluent + 25 percent bio-digester effluent + 25% RDF recorded the highest available N, P_2O_5, K_2O of 285.38, 45.82 and 186.05 kg ha^{-1}, respectively (Mala and Chandrashekhar, 2020b) [30].

2. Effect of liquid organic manures on growth, yield and quality of mulberry leaf

Shwetha (2001) [51] reported that in soybean better growth and yield parameters were observed with the application of organic manures in combination with fermented organics *viz*.,

beejamrutha, jeevamrutha, panchagavya rather than application of only organics (compost, vermicompost and glyricidia green leaf manure).

Muthuvel (2002) [33] conducted an experiment to study the effect of panchagavya and moringa leaf extract on the growth and yield of bhendi. Four sprays of panchagavya @ 3% and moringa leaf extract spray @ 25 ml/ plot resulted in higher plant height, number of branches plant^{-1}, number of fruits plant^{-1}than control (water spray).

Selvaraj (2003) [50] studied the effect of panchagavya on the germination and growth of New Zealand spinach (*Tetragoniatetragonoides).* The results showed that foliar spray of panchagavya 3% on 10th, 20th, 30th, 40th and 50th day after planting (DAP) alone gave 18% higher yield over the conventional method. A french bean variety Ooty-2 registered 36% higher pod yield than conventional method in the given treatment of panchagavya + vermicompost.

Sridhar (2003) [57] observed that the spray of panchagavya at 4% recorded higher plant growth, number of leaves, leaf area, leaf and stem dry weight, single plant yield and yield per hectare in blank night shade (*Solanum nigrum*).

Sivasubramanian and Ganeshkumar (2004) [53] observed the impact of different organic sprays on the growth and yield of African marigold. They found that the vermiwash spraying on marigold produced significantly higher plant height, number of laterals plant^{-1}, number of leaves plant^{-1}, number of flowers plant^{-1} as well as weight of flowers compared to cow dung extract, vermicast extract, cow urine and absolute control.

Velmurugan (2005) [66] studied the effect of organic farming practices on growth, yield and quality of radish cv. Pusa chetki. They observed that as compared to other treatment and control, the seed treatment + foliar application of panchagavya 73% produced the tallest plant height (26.75 cm), higher number of leaves (14.00) and leaf area index (0.94). This treatment also produced maximum individual weight of tubers and tuber yield 5.63 kg plant^{-1} in radish.

Narayanaswamy *et al*. (2006) [34] studied the effect of foliar application of two organic liquids (green leaf and phalada mulberry) on two improved mulberry varieties(S-36 and DD (Vishwa)). Significantly more shoot height (136.30 cm and 144.00 cm), number of leaves per shoot (29 and 39), matured leaf weight (3.20 and 3.56 g), total chlorophyll content (2.12 and 2.20%), soluble sugars (14.34 and 14.41%), crude protein (19.49 and 19.20%) and moisture% (72.98 and 70.40), respectively were observed.

Ramanathan (2006) [39] observed that the panchagavya @ 3% as foliar spray at 0, 30 and 50 days after sowing in rice recorded significantly higher grain yield (5430 kg ha^{-1}) as compared to control without panchagavya spray (4990 kg ha^{-1}) along with the application of different organic manurial treatments.

Saraswathi *et al.* (2006) [49] evaluated the comparative performance of panchagavya and growth regulators on growth and yield of tomato. While, treatment receiving RDF gave significantly higher yield of tomato followed by treatment receiving combined spraying of panchagavya (3%), salicylic acid (100 ppm) and nitrobenzene (150 ppm).

Saraswathi *et al.* (2006) [49] evaluated the comparative performance of panchagavya and growth regulators on growth and yield of tomato. They recorded highest plant height, number of branches plant^{-1} and number of fruits plant^{-1} in the treatment with combined spraying of panchagavya (3%), salicylic acid (100 ppm) and nitrobenzene (150 ppm) followed by RDF as compared to individual spray and other combinations.

Swaminathan *et al.* (2007) [62] concluded that the application of panchagavya at 3% as foliar spray on 15, 25 and 40 days after sowing (DAS) on black gram recorded the higher grain yield of 1195 kg ha^{-1}.

Sanjutha *et al*. (2008) [47] reported that the application of farm yard manure @ 15 t ha^{-1} + N, P_2O_5, K_2O at 75:75:50 kg ha^{-1} + panchagavya at 3% foliar spray recorded the highest growth parameters i.e., plant height, number of branches plant^{-1}, number of leaves plant^{-1}, Leaf Area Index (LAI) in medicinal plant *Andrographis paniculata*.

Ansari (2008) [4] observed that the yield of onion was significantly higher in plots treated with vermiwash (1:10 v/v in water), whereas average weight of onion bulbs was significantly greater in plots amended with vermicompost and vermiwash (1:5 v/v in water).

Karuppaiah *et al*. (2008) [24] conducted trial with treatments of organic manures of farm yard manure (25 t ha^{-1}), inorganic fertilizers of N, P_2O_5, K_2O (60:50:40 kg ha^{-1}) in combination with vermiwash (1:5) dilution, panchagavya (3%) and humic acid (0.20%). The results revealed that the treatment 25 t ha^{-1} of farm yard manure with recommended dose of inorganic fertilizers (60:50:40 N, P_2O_5, K_2O kg ha^{-1}) and foliar application of vermiwash (1: 5) was found best with a total yield of 19.21 ha^{-1} in snake gourd which was at par with treatment combination receiving conservative (minimum) tillage + 25 t ha^{-1} of farm yard manure with recommended dose of in organic fertilizers (60:50:40 kg N, P_2O_5, K_2O ha^{-1}) + foliar application of vermiwash (1: 5 dilution) recorded a total yield of snake gourd 19.06 t ha^{-1}.

Sanjutha *et al.* (2008) [47] revealed that the application of farm yard manure @ 15t ha^{-1} + N, P_2O_5, K_2O @ 75:75:50 kg ha^{-1} + panchagavya @ 3% foliar spray recorded the highest yield parameters *i.e.*, total dry matter production (kg ha^{-1}), dry leaf yield (kg ha^{-1}), dry herbage yield (kg ha^{-1}) in medicinal plant *Andrographis paniculata*.

Vennila and Jayanthi (2008) [69] revealed that the application of 100% recommended dose of fertilizer along with panchagavya spray (2%) significantly increased the number of fruits plant^{-1}, fruit weight g fruit^{-1} and fruit yield q ha^{-1} of okra.

Yamgar (2008) [72] studied the effect of organic fertilizers on growth of mulberry. The study revealed that the highest shoot length (255.75 cm), leaf area (259.50 cm^2), leaf yield plant^{-1} (653.75 g) and leaf yield per hectare (544.76 kg) were recorded in vermicompost + vermiwash spray.

Sankar *et al*., (2009) [48] reported that the treatment consisting of 100% recommended dose of N, P_2O_5, K_2O + panchagavya when applied at 30, 45 and 60 DAT to onion had significantly increased the plant height and average weight of bulb (52.70 g).

Kumawat *et al.* (2009) [27] studied the response of panchagavya and plant leaf extract on cumin (*Cuminum cyminum* L.) in arid western Rajasthan. They reported that the foliar application of neem extract with panchagavya in 1:1 combination recorded significantly higher dry matter in plant, plant height and branches plant^{-1} as compared to control and leaf extracts of datura and tumba (*Citrullus colocynthis*). As compared to control, neem + panchagavya increased grain, straw and biological yield by 58, 72 and 65%, respectively.

Gorakhnath and Singh (2009) [20] evaluated the impact of vermiwash prepared from different sources on the growth, flowering and productivity of okra, lobia, and radish. Treatment receiving vermiwash significantly increased the growth, productivity and early starting of flowering. Significantly highest growth in okra and radish was observed in vermiwash prepared from buffalo dung with rice bran, whereas, the highest growth in lobia was observed in vermiwash prepared from

buffalo dung with gram bran.

Malarvizhi *et al*. (2009) [32] the application of panchagavya at 2% recorded the highest plant height of (68.00 cm) and increase in the number of primary branches plant^{-1} in paprika cv. Kt-PI-19.

Sankar *et al*. (2009) [48] reported that panchagavya + 100% recommended dose of N, P_2O_5, K_2O fertilizers followed by panchagavya + 50% farm yard manure + 50% poultry manure helped in maintaining a higher number of leaves in onion throughout the cropping period.

Venkataramana *et al*. (2009) [68] observed that foliar spray of vermiwash at 200 ppm twice on V-1 mulberry at 25 and 35 days after pruning had significantly increased the plant height (199.50 cm), shoot length (189.00 cm), number of branches plant^{-1} (13.00) and number of leaves plant^{-1} (155.00).

Venkatlakshmi *et al*. (2009) studied the effect of seed treatment and foliar spray of panchagavya on growth and yield of *Amaranthus viridae* at Tamil nadu Agricultural University and found that foliar spray of panchagavya at 3% recorded significantly higher plant height, number of leaves, and leaf area index. Whereas, seeds soaked in panchagavya solution also recorded significantly higher plant height, number of leaves, dry matter production and leaf area index at 15 and 25 DAS in amaranthus.

Venkataramana *et al.* (2009) [68] observed that the foliar spray of vermiwash @ 200 ppm twice on V-1 mulberry at 25 and 35 Days after Pruning significantly improved the leaf yield (72600 kg ha^{-1}year^{-1}) over unsprayed mulberry (45735 kg ha^{-1}year^{-1}).

Venkatalakshmi *et al.* (2009) [67] observed that the amaranthus seeds soaked in panchagavya solution recorded significantly higher dry matter production and leaf area index at 15 and 25 DAS. The dry matter production (1.66 t ha^{-1}) and green leaf yield (10.05 t ha^{-1}) were also significantly higher treatment of foliar spray of panchagavya 3%.

Dipping chilli seedlings in beejamrutha, soil application of jeevamrutha (500 litres ha^{-1}) at 10 days after transplanting and foliar application of panchagavya @ 3% at the time of flowering recorded higher ascorbic acid and capsaicin content in chilli fruits.

Gore and Sreenivasa (2011) [21] studied the influence of liquid organic manures *viz*., panchagavya, jeevamrutha and beejamrutha on the growth, nutrient content and yield of tomato. The significantly highest plant growth and root length was recorded with the application of RDF + beejamrutha + jeevamrutha + panchagavya and it was found to be significantly superior over other treatments.

Gore and Sreenivasa (2011) [21] studied the influence of liquid organic manures *viz*., panchagavya, jeevamrutha and beejamrutha on the growth, nutrient content and yield of tomato. The application of beejamrutha + jeevamrutha + panchagavya was best treatment and resulted in significantly higher yield as compared to RDF alone.

Kumawat *et al*. (2011) [26] revealed that the foliar application of panchagavya plus neem in cluster bean recorded higher grain (34%), straw (21%) and biological yield (25%) compared to control and also increased pod length (from 5.02 to 5.32 cm), pods plant^{-1} (80.32 to 128.95), pod weight plant^{-1} (2.05 to 43.70 g), average seeds per pod (7.53 to 8.20), seed weight plant^{-1} (14.86 to 23.04 g) and average 100 seed weight (3.17 to 3.27 g).

Ravichandran *et al*. (2011) [44] studied the effect of foliar spray of panchagavya on the yield of potato and recorded higher total number of the tubers (5,75,000 ha^{-1}) and total tuber yield of 28.69 t ha^{-1} in the treatment receiving 3% spraying of panchagavya at 15 days interval as compared to 3% spraying of panchagavya at 8 days interval and control. Further, they have also observed that soaking the produce in 3% panchagavya solution before storage reduced weight loss, delay the sprouting leading to improve storability of seed potatoes.

Significantly higher plant height (143.21 cm), root length (19.80 cm) and number of fruits (23.25) were observed in tomato treated with RDF + beejamrutha + jeevamrutha + panchagavya over other treatments and found to be best compared to RDF alone (125.35 cm, 13.58 cm and 15.25 cm, respectively) (Neelima and Sreenivasa, 2011) [35].

Suresh Kumar *et al*. (2011) [60] revealed that the foliar application of panchagavya as organic nutrient in black gram significantly increased pods plant^{-1}, number of seeds per pod, grain yield and test weight by 20.00, 7.00, 4.20 kg and 3.90 g respectively over N, P_2O_5, K_2O (18.00, 5.00, 3.50 kg and 2.70 g, respectively) and control (15.00, 3.00, 2.10 kg and 1.60 g, respectively). Panchagavya treated plants showed higher amount of chlorophyll a, b and total chlorophyll contents in fresh leaves.

Tharmaraj *et al*. (2011) [64] concluded that panchagavya used as biofertilizer in crops like *Vigna radiata*, *Vigna mungo*, *Arachis hypogaea*, *Cyanopsis tetragonoloba*, *Lablab purpureus*, *Cicer arietinum* and *Oryza sativa* promoted the production of lateral roots, leaves, leaflets and the growth of lamina in all the plants compared to control and the surface area of leaves was 93% more than that of their respective control. Nodule formation increased by nearly 18 to 62%.

Tharmaraj *et al.* (2011) [64] conducted an experiment to study the influence of vermicompost and vermiwash on growth and yield of rice. They found higher number of leaves, leaf length, height of the plant and root length in the treatment of soil application of vermicompost and spray of vermiwash over control and its individual application.

Ravichandran *et al.* (2011) [44] applied 3% panchagavya solution on organically grown potato crop by spraying at 15 days interval and soaking its produce in the same solution before storage proved to be advantageous as it reduced the weight loss, reduced the sprout growth and delayed the sprouting and leading to improved storability of seed potatoes.

Vivek (2011) [71] conducted a study to know the effect of foliar spray of organic formulations on mulberry. The results revealed that the foliar spray of 5% vermiwash has significantly increased the plant height (87.42 cm), shoot height (86.14 cm), number of leaves per shoot (16.40) and leaf yield of 566.00 g/plant. Further, significantly higher amount of chlorophyll ‘a’, chlorophyll ‘b’ and total chlorophyll was recorded in the same treatment.

Anuja and Archana (2012) [6] studied the effect of organic nutrients on yield and quality of bitter gourd. The organic manures were applied alone and their combinations with and without liquid manure. They observed that all the organic treatments proved to be superior to the control with yield. Application of farm yard manure @ 25 t ha^{-1} + vermicompost @ 5 t ha^{-1} + panchagavya at 3% recorded highest fruit yield per vine i.e., 1489 g in season-I and 1616 g in season-II.

Chadha *et al*. (2012a) [11] reported that the application liquid manures (10% concentration) when applied at 30, 45 and 60 DAT in onion gave significantly higher bulb yield per plot than control. The maximum bulb yield (184.10 q ha^{-1}) was recorded with application of vermiwash as against 167.34 q ha^{-1} in control.

Chadha *et al.*, (2012b) [12] observed that the foliar application of panchagavya 3% gave significantly higher yield of onion to the extent of 168.90 q ha^{-1}.

Results of the field trial conducted to know the performance of

groundnut under integrated organic nutrient supply systems indicated significantly higher pod and haulm yields (2304 kg ha^{-1} and 2695 kg ha^{-1}, respectively) with the application of farm yard manure (7.5 t ha^{-1}) + *Rhizobium* + PSB + 3% panchagavya spray at 30, 60 and 75 DAS as compared to other treatments except application of farm yard manure (7.50 t ha^{-1}) + *Rhizobium* + PSB + jeevamrutha based on N equivalent (2249 kg ha^{-1} and 2620 kg ha^{-1}), respectively (Ravi Kumar, 2012) [41].

Ravi *et al*. (2012) [41] found that integration of 75% RDF + in situ green manuring of sunhemp, biofertilizer (*Azospirillum* + PSB) and liquid manures like panchagavya foliar spray at 3% and soil application of jeevamrutha helps to save 25% RDF by producing grain yield on par with that of 100% RDF.

Boraiah (2013) [8] reported that application of jeevamrutha resulted in 7.98 to 26.20% increase in fruit yield of chilli as compared to without jeevamrutha application. This might be due to higher number of fruits plant^{-1} (43.99 to 56.31), fruit length (6.82 to 7.43 cm), total dry matter plant^{-1} (10.46 to 15.67 g), fruit girth (16.81 to 17.19 cm) and fruit weight (126.12 to 125.67 g).

Choudhari *et al*. (2013) [14] reported that in groundnut foliar application of panchagavya and leaf extract of neem recorded significantly higher number of nodules, number of pods plant^{-1}, pod weight plant^{-1}, pod yield, haulm yield, harvest index, 100 kernels weight, cocoon shelling%, nitrogen and phosphorus uptake and oil content over other sources.

Patel *et al*. (2013) [36] studied the effect of panchagavya on growth and yield of cowpea. The foliar spray of panchagavya 3% at 20 & 40 DAS recorded number of seeds plant^{-1} (11.33), 100 seed weight (8.30 g) and seed yield plant^{-1} (8.33 g). The highest seed yield (1509 kg ha^{-1}) and stover yield (2373 kg ha^{-1}) was also recorded under this treatment.

Patel *et al*. (2013) [36] studied the effect of panchagavya on growth and yield of cowpea and observed that the foliar spray of panchagavya 3% at 20 & 40 DAS was found to be superior and recorded maximum dry matter accumulation, 38.73 g, 66.67 g and 92.00 g at 30 DAS, 60 DAS and at harvest in that order. Similarly, the highest number of branches (6.00), number of pod plant^{-1} (12.33), pod length (11.89 cm) and root nodules plant^{-1} (18.33) were recorded.

Vimalendran and Wahab (2013) [70] studied the effect of foliar spray of panchagavya on the growth and yield of baby corn. The results revealed that four sprays of 3%panchagavya at 15, 25, 35 and 45 Days after Sowing (DAS) along with 100% Recommended Dose of Fertilizers (RDF) recorded the highest fresh baby corn yield (7439 and 7476 kg ha^{-1}, in 2008 and 2009, respectively) followed by 3 sprays of 3% panchagavya along with 100% Recommended Dose of Fertilizer (7226 kg ha^{-1} in 2008 and 7262 kg ha^{-1} in 2009).

Desai *et al*. (2014) [15] reported that in cowpea foliar spray of panchagavya @ 6% at flowering + soil application of jeevamrutha @ 500 litres ha^{-1} at 20 days after sowing along with 75% recommended dose of fertilizer registered significantly higher seed yield, stover yield, root nodules plant^{-1} as well as quality attributes *viz*., protein content and chlorophyll index of leaves and has also improved N and P content in seeds and stover and total uptake of N and P by summer cowpea.

Gopakkali and Sharanappa (2014) [19] conducted an experiment at Zonal Agriculture Research Station, GKVK, Bengaluru, under organic crop production and reported that the application of Enriched Bio Digested Liquid Manure (EBDLM) at 100 kg N eq ha^{-1} + 3 sprays of panchagavya at 3% in onion recorded the highest fresh weight of bulb, neck diameter, bulb length, bulb size index and bulb yield.

Gopakkali and Sharanappa (2014) [19] reported that the application of enriched biodigested liquid manure (EBDLM) at 100 kg N eq ha^{-1} + 3 sprays of panchagavya at 3% in onion recorded the highest plant height, number of leaves plant^{-1}, leaf diameter, leaf area index, and total dry matter plant^{-1}.

Jadhav *et al*. (2014) [22] conducted an experiment on effect of different levels of vermiwash sprays on growth and yield of fenugreek. The results indicated that the application of vermiwash foliar three times spray of 2% at 15, 30 and 45 DAS had showed significantly higher plant height (84.10 cm), root length (18.37 cm), number of branches plant^{-1} (6.80).

Jadhav *et al*. (2014) [22] studied the effect of different levels of vermiwash sprays on growth and yield of fenugreek. The results indicated that the treatment of 2% vermiwash foliar spray three times at 15,30 and 45 DAS had showed significantly higher total number of pods plant^{-1} (34.48), straw weight plot^{-1} (0.85 kg), seed weight (1161.33 kg) and straw weight (2833.73 kg), respectively.

Swain *et al*. (2014) [61] revealed that foliar application of panchagavya at 3% concentration (30 ml litre^{-1} of solution) at 10 days interval in chilli produced the highest fruit set percentage (56.25%), yield plant^{-1} and yield per hectare (21.95 q ha^{-1}).

Uma Amareswari and Sujathamma (2014) [65] reported that higher percentage of ascorbic acid (10.57%) was observed in the fresh pods which received using straw mulch, vermicompost and panchagavya together followed by use of straw mulch, jeevamrutha and panchagavya in French bean. For riboflavin content higher values were recorded with (0.41 and 0.40) using straw mulch, N, P_2O_5, K_2O (recommended dose of fertilizers) and panchagavya.

Basavaraj *et al*. (2015) [7] reported that higher levels of nitrogen @ 200% N equivalent through farm yard manure recorded significantly higher french bean yield (134.60 q ha^{-1}) as compared to 100% N equivalent (120 q ha$^{-1)}$ and it was on par with farm yard manure at 150% N equivalent (133.00 q ha^{-1}). Soil application of jeevamrutha recorded significantly higher pod yield of french bean (141.70 q ha^{-1}) compared to without jeevamrutha application (117.00 q ha^{-1}) and foliar spray of panchagavya @ 3% recorded significantly higher pod yield (138.70 q ha^{-1}) compared to without panchagavya spray (120.00 q ha^{-1}).

Jandaik *et al*. (2015) [23] conducted an experiment on efficacy of cow urine as plant growth enhancer and antifungal agent and results showed that plant height of methi increased with increase in concentration of cow urine and duration of time. Maximum plant height of methi was 14.30 ± 0.40 cm with maximum concentration that is of 5% of cow urine. The mean height of methi plants was 9.00 ± 0.46 cm in control plants. Shoot length of methi was 7.27± 0.25, 7.97 ± 0.25, 9.17 ± 0.31, 9.67 ± 0.25 and 10 ± 0.20 cm when sprayed with 1,2,3,4 and 5% concentration of cow urine, respectively.

Kumar and Neeraj (2015) [25] evaluated the performance of different onion varieties in response to organic condition during the *rabi* season of the year 2014-15, the pre harvest effect of the commercial bio-based product namely *Trichoderma viridae*, neem, panchagavya and water were studied. The results revealed that maximum vegetative growth (plant height, number of leaves) was observed in case of panchagavya treatment.

Kumar and Neeraj (2015) [25] evaluated the pre harvest effect of the commercial bio-based product namely *Trichoderma viridae*, neem, panchagavya and water in onion. It was revealed from the results that the maximum bulb growth (bulb diameter, bulb weight) was observed in case of panchagavya treatment.

Rani and Evanjaline (2015) [40] studied the effect of *Kappaphycus alvareizii* SLF (Seaweed Liquid Fertilizer) on

growth and biochemical parameters of mulberry. The higher shoot growth (30.70 cm), number of leaves (40.00), leaf area (330.25 cm^2) was recorded in mulberry plants irrigated with 1% SLF. Further, total soluble protein (45.62 mg/g), carbohydrate (51.54 mg/g) and total free amino acid (45.58 mg/g) were observed in the same treatment.

Yogananda *et al.* (2015) [73] reported that application of 100% N equivalent compost along with recommended dose of farm yard manure, jeevamrutha and beejamrutha has registered significantly higher plant height (70.13 cm), number of leaves (63.53), number of branches (8.47), grain yield (1740 kg ha^{-1}) and stover yield (1864 kg ha^{-1}) of cowpea when compared to application of compost and liquid manures.

Siddappa *et al.* (2016) [52] revealed that application of jeevamrutha at 1500 litres ha^{-1} has recorded significantly higher grain yield (1246 kg ha^{-1}) of field bean when compared to without application of jeevamrutha (808 kg ha^{-1}).

Sudhir (2016) [59] carried out a study to know the effect of foliar spray of organic formulation on growth and biochemical constituent of mulberry. Results revealed that foliar spray of vermiwash at 10% significantly influenced the plant height (93.51 cm), number of shoots $plant^{-1}$ (19.85), number of leaves $plant^{-1}$ (272.10) and leaf yield (533.00 g/plant). The higher leaf moisture content, carbohydrates, chlorophyll content, protein content and the highest N, P_2O_5, K_2O content were recorded in the same treatment.

Anil *et al.* (2017) [2] studied the effect of application of SLF *Aschophylum nodosum* on yield and quality of mulberry. The data revealed that the foliar application of seaweed extract enhanced leaf yield $plant^{-1}$ by 72.47%, average plant height by 92.36% and protein content by 67.30%.

Boraiah *et al.* (2017) [9] evaluated the effect of organic liquid formulations on growth and yield of capsicum. The results indicated that the application of panchagavya 6% spray recorded significantly higher fruit yield (30.25, 37.49, 48.91, 118.91, 96.15, 86.29 and 47.81 q ha^{-1} at 60, 70, 80, 90, 100, 110 and 120 DAT, respectively).

Fazulla *et al.* (2017) [18] studied the effect of soil amendments and organic foliar sprays on crop growth, seed yield and quality of green gram (*Vigna radiata* L.). The application of farm yard manure (1/3) + vermicompost (1/3) + glyricidia leaf manure (1/3) equivalent to 100% RDF and foliar spray of panchagavya 3% at flower initiation and 15 DAF recorded significantly more number of pods $plant^{-1}$ (21.27), pod length (10.25 cm), shoot length (16.53 cm) and root length (18.25 cm) as compared to other treatment combinations and control.

Fazulla *et al.* (2017) [18] studied the effect of soil amendments and organic foliar sprays on crop growth, seed yield and quality of green gram (*Vigna radiata* L.). The results indicated that the application of farm yard manure (1/3) + vermicompost (1/3) + glyricidia leaf manure (1/3) equivalent to 100% RDF and foliar spray of panchagavya 3% at flower initiation and 15 DAF recorded significantly number of seeds per pod (12.10), seed yield (12.89 g) and seed yield (1263.68 kg^{-1}) as compare to other treatment combinations and control.

Anita *et al.* (2018) [3] studied the effect of organic formulations on growth of mulberry at nursery stage. The results revealed that the maximum plant height (103.91 cm) and number of leaves per shoot (16.58), maximum root length (71.83 cm), leaf length (20.76 cm) was recorded in mulberry plants treated with jeevamrutha at 40, 60, 60 and 40%, respectively.

Devamani (2018) [17] studied the influence of integrated nutrient management on V-1 mulberry variety. The results revealed that the mulberry growth and yield parameters were significantly differed with INM treatment, significantly higher plant height (171.10 cm), number of shoots $plant^{-1}$ (9.70), number of leaves $plant^{-1}$ (368.20) and leaf yield $plant^{-1}$ was recorded in 3 MT vermicompost + 12 litres panchagavya at 3% level $acre^{-1}$ $year^{-1}$ over other treatments.

Sudhakar *et al.* (2018) [58] studied the effect of eco-friendly inputs under graded levels of inorganic fertilizers on growth of V-1 mulberry. The results revealed that greater number of branches $plant^{-1}$ (8.90), number of leaves $plant^{-1}$ (274.60) and higher leaf area (192.50 cm^2) was observed when liquid organic manures were applied in combination with graded levels of inorganic fertilizers. Further, the highest leaf moister content of 74.84% was recorded in T_5 (N_{350} P_{140} + 20 MT farm yard manure along with 7% panchagavya spray).

Mala and Chandrashekhar (2020a) [29] studied the influence of seri-waste bio-digester on growth and yield of mulberry. The results indicated that the maximum plant height (163.19 cm), number of branches $plant^{-1}$ (13.32), number of leaves per branch (33.00) and leaf yield (1012.33 g/plant) was recorded in mulberry plot applied with 50% seri bio-digester effluent + 25% bio-digester effluent + 25% RDF over control. Further, the highest macronutrients and secondary nutrient content of mulberry leaf was recorded maximum in 50% seri bio-digester effluent + 25% bio-digester effluent + 25% RDF over 100% RDF.

3. The effect of liquid organic manures on performance of silkworm

Yamgar (2008) [72] studied the effect of organic fertilizers on economic traits of MYs × CSR2 silkworm. Higher larval weight (38.80 g/10 larvae), single cocoon weight (1.35 g), single cocoon shell weight (0.25 g), cocoon shell percentage (18.63) and filament length (813.25 m) were recorded in vermicompost + vermiwash treatment.

Vivek (2011) [71] conducted a study to know the effect of foliar spray of organic formulations on rearing performance of silkworm. The data revealed that matured larval weight (41.79 g), silk productivity (5.78 cg/day), ERR (99.43%) and pupal weight (17.03 g/10 pupae) were significantly more in silkworm fed with 5 percent vermiwash treated mulberry leaves.

Sudhir (2016) [59] studied the effect of foliar spray of organic formulation on growth parameters of silkworm. The study revealed that the silkworm growth and cocoon traits *viz*., cocoon weight (19.10 g/10 cocoons), cocoon shell weight (3.96 g/10 cocoon shells), cocoon shell ratio (17.93%), pupal weight (16.19 g/10 pupae), pupation% (99.93), ERR (98.10%) and silk filament length (916.54 m) were significantly more in mulberry leaves sprayed with 10% vermiwash.

Devamani (2018) [17] studied the impact of integrated nutrient management on PM X CSR2 silkworm traits. The results revealed that cocoon shell weight (2.00 g), cocoon shell weight (0.51 g), cocoon shell ratio (25.50%) and larval weight (4.40 g) and pupal weight (1.52 g) was found be higher in T_3 (3 MT vermicompost + 12 litres panchagavya at 3% $levelacre^{-1}year^{-1}$ over other treatments.

Mala (2018) studied the influence of seri-waste bio-digester on rearing performance of silkworm. The results revealed that maximum cocoon weight (1.86 g), pupal weight (1.53 g), cocoon shell weight (0.30 g), cocoon shell ratio (16.60%) and single filament length (915.10 m) were recorded in 50% seri bio-digester effluent + 25% bio-digester effluent + 25% RDF treatment.

Sudhakar *et al.* (2018) [58] studied the influence of ecofriendly inputs on the commercial parameters of silkworm rearing. The

study revealed that higher ERR/10000 larvae (9655.33 by number) was observed in N_{350} P_{140} + 20 MT farm yard manure + vermicast wash and panchagavya spray. Whereas, maximum single cocoon weight (1.92 g), single cocoon shell weight (0.40 g) and higher cocoon shell ratio of 20.70% was recorded in N_{350} P_{140} + 20 MT farm yard manure.

Thangaroja *et al*. (2018) [63] studied the efficacy of organic foliar formulation on growth and quality of mulberry. The results revealed that among the different treatments effective microorganisms (EM) showed better performance on the mulberry growth and yield parameters *viz*., shoot length (164.00 cm), number of leaves per shoot (9.08), leaf area (185.00 cm^2), internodal distance (5.63 cm) and leaf yield $plant^{-1}$ (881.43 g). Further EM also increased the moisture content (77.11%), chlorophyll 'a' (1.12 mg/g), chlorophyll 'b' (0.65 mg/g) and total chlorophyll (1.81 mg/g), soluble protein content (32.45 mg/g) and total carbohydrates (40.74 mg/g).

Conclusion and future prospective

The organic carbon content, water-holding capacity and fertility of soil can be enhanced with the use of liquid organic manures. Additionally, they can supply nutrients to microorganisms that decompose organic debris and establish a thriving ecosystem in the soil. Liquid organic manures can aid in mulberry plant growth, enhance nutrient absorption, and help overcome transient nutrient deficits. Mineral fertilizers can be replaced with liquid organic manures, which can also assist cut down on the usage of chemicals. It is necessary to do research on how applying liquid organic manures to the soil affects the biological characteristics of the soil. It is necessary to investigate the nutrient release pattern of liquid organic manures applied to soil.

References

1. Ali MN, Ghatak S, Ragul T. Biochemical analysis of panchagavya and sanjivani and their effect in crop yield and soil health. J Crop Weed. 2011;7(2):84-6.
2. Anil P, Bariampan L, Trivedy K. Effect of application of Ascophyllum nodosum extract on the yield and quality of mulberry leaves. Biosci Discov. 2017;8(2):235-40.
3. Anita K, Bharti, Devi S, Thakur IK, Suman K, Neeraj S. Effect of organic formulations on growth of mulberry (*Morus alba* L.) at nursery stage. Int J Chem Stud. 2018;6(6):974-8.
4. Ansari AA. Effect of vermicompost and vermiwash on the productivity of spinach (*Spinacia oleracea*), onion (*Allium cepa*) and potato (*Solanum tuberosum*). World J Sci. 2008;4(5):554-7.
5. Ansari AA, Sukhraj K. Effect of vermiwash and vermicompost on soil parameters and productivity of okra (*Abelmoschus esculentus*) in Guyana. Afr J Agric Res. 2010;5(14):1794-8.
6. Anuja S, Archana. Effect of organic nutrients on yield and quality of bitter gourd. Int J Agric Sci. 2012;8(1):205-8.
7. Basavaraj K, Devakumar N, Latha B, Somanatha AC. Effect of organic liquid manure, jeevamrutha and panchagavya on yield of French bean (*Phaseolus vulgaris* L.). In: Proceedings of National Symposium on Organic Agriculture; c2015 Feb 14-15; Tamil Nadu. p. 111.
8. Boraiah. Effect of organic liquid formulations and manures on growth and yield of capsicum [PhD thesis]. Bangalore (IN): Univ Agric Sci.; c2013.
9. Boraiah B, Devakumar N, Shubha S, Palanna KB. Effect of panchagavya, jeevamrutha and cow urine on beneficial microorganism and yield of capsicum (*Capsicum annuum* L. var. grossum). Int J Curr Microbiol App Sci. 2017;6(9):3226-34.
10. Bui X, Preston TR. Low-cost polyethylene tube bio-digesters on small-scale farms in Vietnam. In: Second International Conference on Increasing Animal Production from Local Resources; 1999. p. 1-10.
11. Chadha S, Rameshwar, Ashlesha, Saini JP, Paul YS. Vedic Krishi: sustainable livelihood option for small and marginal farmers. Indian J Trad Knowl. 2012b;11(3):480-6.
12. Chadha S, Rameshwar, Ashlesha, Saini JP, Paul YS. Vedic Krishi: sustainable livelihood option for small and marginal farmers. Indian J Trad Knowl. 2012a;11(3):480-6.
13. Chaithra M. Effect of farm yard manure and jeevamrutha on growth and yield of sunflower (Helianthus annus L.) [MSc thesis]. Bangalore (IN): Univ Agric Sci.; c2018.
14. Choudhari A, Patel DM, Patel GN, Patel SM. Effect of various organic sources of nutrients on growth and yield of summer green gram [*Vigna radiata* (L.) Wilczek]. Crop Res. 2013;46(1-3):70-3.
15. Desai CM, Patel GN, Patel DM, Desai CK, Mistry BI. Effect of liquid bio-nutrients in conjunction with inorganic fertilizers on yield, quality and nutrient uptake by summer cowpea [*Vigna unguiculata* (L.) Walp.]. Crop Res. 2014;48(1-3):42-6.
16. Devakumar N, Shubha S, Gouder SB, Rao GGE. Microbial analytical studies of traditional organic preparations beejamrutha and jeevamrutha. In: Proceedings of the Fourth ISOFAR Scientific Conference; c2014 Oct 13-15; Istanbul, Turkey. p. 639.
17. Devamani M. Impact of INM on selected mulberry and silkworm traits. Int J Sci Res. 2018;8(3):1207-10.
18. Fazulla SA, Sajjan AS, Babalad HB, Nagaraj LB, Palankar GS. Effect of organics on seed yield and quality of green gram (*Vigna radiata* L.). Legume Res. 2017;40(2):388-92.
19. Gopakkali P, Sharanappa. Effect of organic farming on growth, yield, quality and economics of onion (*Allium cepa*) in Dry Zone of Karnataka. Indian J Agron. 2014;59(2):103-7.
20. Gorakhnath, Singh K. Utilization of vermiwash potential on certain vegetable crop. J Cent Eur Agric. 2009;10(4):417-26.
21. Gore N, Sreenivasa MN. Influence of liquid organic manures on growth, nutrient content and yield of tomato (*Lycopersicon esculentum* Mill.) in the sterilized Soil. Karnataka J Agric Sci. 2011;24(2):153-7.
22. Jadhav PB, Patil NB, Saravaiya SN, Dekhane SS, Tekale GS, Harad NB, Jadhav KP, Patel DJ. Effect of different level of vermiwash spray on growth and yield of fenugreek cv. local. Int J Dev Res. 2014;4(8):1547-9.
23. Jandaik S, Thakur P, Kumar V. Efficacy of cow urine as plant growth enhancer and antifungal agent. Adv Agric. 2015;2015:620368.
24. Karuppaiah P, Balasankari K. Effect of tillage system and nutrients on growth, yield on snake gourd and residual soil fertility under rice fallow condition. Asian J Hortic. 2008;3(1):70-3.
25. Kumar, Neeraj. Evaluation of the performance of onion varieties in response to organic cultivation. Int J Adv Res. 2015;3(9):1558-62.
26. Kumawat RN, Mahajan SS, Mertia RS. Growth and yield of *Cyamopsis tetragonoloba* grown on light-textured soils with foliar application of fermented panchagavya. Indian J Agric Sci. 2011;81(3):230-5.
27. Kumawat RN, Mahajan SS, Mertia RS. Response of cumin

(*Cuminum cyminum* L.) to panchagavya and plant leaf extracts in arid western Rajasthan. J Spices Aromatic Crops. 2009;18(2):92-9.
28. Lavanya G, Devakumar N, Latha B, Ramesh Kumar C. Influence of jeevamrutha and panchagavya on beneficial soil microbial population in organic field bean. In: Proceedings of the National Conference on Sustainable and Self Sufficient Production of Pulses through an Integrated Approach; c2016. p. 98.
29. Mala PH, Chandrashekhar S. Influence of seri-waste bio-digester on biochemical constituents, growth and yield of mulberry. Int J Chem Stud. 2020a;8(4):2373-7.
30. Mala PH, Chandrashekhar S. Physico-chemical properties of mulberry field soil as influenced by the application of seri-waste bio-digester effluent. Int J Chem Stud. 2020b;8(2):1312-4.
31. Mala PH. Influence of sericulture waste bio digester on growth and yield of mulberry and silkworm [M.Sc. thesis]. Bengaluru, Karnataka, India: Univ. Agric. Sci.; c2018. p. 30-49.
32. Malarvizhi K, Ponnuswami V, Kavino M, Selvi BS. Effect of growth promoters on growth and yield of paprika cv. Kt-P1-19. Crop Res. 2009;37(1, 2, 3):144-7.
33. Muthuvel. Effect of organics on growth and yield of Bhendi var. Varsh Uphar. In: Vadivel E, editor. Panchagavya as potentiator of plant cells: Effects on crop plants and the physiology that validates the effects. Proc. Nation. Conf. on Glory of Gomatha; c2007 Dec 1-3; Tirupati, A.P.: S.V. Veterinary University; c2002. p. 143-8.
34. Narayanaswamy TK, Srinivasa Gowda R, Chandrappa D, Ravikumar A. Effect of foliar application of organic liquids on mulberry. Bull Indian Acad Seri. 2006;10(1):67-9.
35. Neelima SG, Sreenivasa MN. Influence of liquid organic manures on growth, nutrient content and yield of tomato (*Lycopersicon esculentum* L.) in the sterilized soil. Karnataka J Agric Sci. 2011;24(2):153-7.
36. Patel MM, Patel DM, Patel KM. Effect of panchagavya on growth and yield of cowpea (*Vigna unguiculata* L. WALP.). AGRES An Int e-J. 2013;2(3):313-7.
37. Perminder SB. Effect of organic management practice on soil properties under capsicum (Capsicum annum L.) [M.Sc. thesis]. Solan, HP: Dr. Yashwant Singh Parmar Univ. Hortic. Forestry; c2017.
38. Preston TR, Leng RA. The greenhouse effect and its implications for world agriculture. The need for environmentally friendly development. Livestock Res Rural Dev. 1989;1(1):21-30.
39. Ramanathan KM. Organic farming for sustainability. J Indian Soil Sci. 2006;54(4):418-25.
40. Rani SMV, Evanjaline MR. Effect of Kappaphycus alvaerezii SLF on growth and biochemicals in *Morus alba* L. and *Bombyx mori* L. Int J Res Stud Biosci. 2015;3(12):47-52.
41. Ravi Kumar HS. Integrated organic nutrient supply systems on growth and yield of groundnut (*Arachis hypogaea* L.) [M.Sc. thesis]. Bengaluru, Karnataka, India: Univ. Agric. Sci.; c2012.
42. Ravi Kumar HS, Venkate Gowda J, Sridhar D, Poornima DS. Effect of integrated organic sources of nutrients on quality and economics of groundnut (*Arachis hypogaea* L.). Adv Res J Crop Improv. 2011;2(1):81-5.
43. Ravi N, Basavarajappa R, Chandrashekar CP, Harlapur SI, Hosamani MH, Manjunatha MV. Effect of integrated nutrient management on growth and yield of quality protein maize. Karnataka J Agric Sci. 2012;25(3):395-6.
44. Ravichandran G, Natarajan N, Manorama K, Vanangamudi K. Effect of organic sprays on storage behaviour of seed potatoes. Indian J Hortic. 2011;68(3):399-407.
45. Ravisankar N, Panwar AS, Prasad K, Vipin Kumar, Bhaskar S. Organic farming crop production guide. Modipuram, Meerut, Uttar Pradesh, India: Network Project on Organic Farming, ICAR-Indian Institute of Farming Systems Research; c2017. p. 586.
46. Sakthivel N, Ravikumar J, Chikkanna, Mukund VK, Bindroo BB, Sivaprasad V. Organic farming in mulberry: Recent breakthrough. Tech Bull. Salem, Tamil Nadu, India: RSRS; c2014.
47. Sanjutha S, Subramanian S, Indu Rani C, Maheswari J. Integrated nutrient management in *Andrographis paniculata*. Res J Agric Biol Sci. 2008;4(2):141-5.
48. Sankar V, Veragagavathatham D, Kannan M. Organic farming practices in white onion (*Allium cepa* L.). J Ecobiol Agril. 2009;4(1):17-21.
49. Saraswathi T, Vadivel E, Rajamani K, Hemalatha P, Venkatesan S. Comparative performance of panchagavya and growth regulators in increasing growth and yield of tomato. South Indian Hortic. 2006;54(1-6):181-5.
50. Selvaraj N. Report of work done on organic farming at horticulture research station. Ooty, India: TNAU; c2003. p. 2-5.
51. Shwetha BN. Effect of nutrient management through organics in soybean-wheat cropping system [M.Sc. thesis]. Dharwad, Karnataka, India: Univ. Agric. Sci.; c2001.
52. Siddappa, Murali K, Devakumar N. Organically grown field bean (Lablab purpureus var. lignosus) using jeevamrutha and farm yard manure. Natnl Conf Sust Self Suffic Prodn Pulses Integr Approach. Bengaluru, India; c2016. p. 105.
53. Sivasubramanian K, Ganeshkumar M. Influence of vermiwash on biological productivity of marigold. Madras Agric J. 2004;91(4-6):221-5.
54. Somasundaram E, Singaram P. Modified panchagavya for sustainable organic crop production. Natl Semin Standards Technol Non-Convent Org Inputs. 2006.
55. Somasundaram E, Sankaran N, Meena S, Thiyagarajan TM, Chandaragi KK, Panneerselvam S. Response of greengram to varied concentrations of panchagavya (organic nutrition) foliar application. Madras Agric J. 2003;90:169-72.
56. Sreenivasa MN, Naik N, Bhat SN, Nekar MM. Effect of organic liquid manures on growth, yield and quality of chilli (*Capsicum annuum* L.). Green Farming. 2010;1(3):282-4.
57. Sridhar T. Effect of bio-regulators on black night shade (Solanum nigrum L.) [M.Sc. thesis]. Coimbatore, Tamil Nadu, India: TNAU; c2003.
58. Sudhakar P, Hanumantharayappa SK, Jalala SK, Sivaprasad V. Organic farming through the incorporation of eco-friendly inputs under graded levels of inorganic fertilizers for sustainable mulberry (*Morus alba* L.) leaf production and protection. Asian J Sci Technol. 2018;9(3):7803-7.
59. Sudhir K. Effect of foliar spray of organic formulations on biochemical constituents of mulberry and growth parameters of silkworm (*Bombyx mori* L.) [M.Sc. thesis]. Dharwad, Karnataka, India: Univ. Agric. Sci.; c2016. p. 39-86.
60. Suresh Kumar R, Ganesh P, Tharmaraj K, Saranraj P. Growth and development of blackgram (*Vigna mungo*) under foliar application of panchagavya as organic source of nutrient. Curr Bot. 2011;2(3):9-11.
61. Swain SS, Sahu GS, Mishra N. Response of chilli

(*Capsicum annuum* L.) cv. Kuchinda local to varied levels of panchagavya. e-planet. 2014;12(2):25-8.
62. Swaminathan C, Swaminathan V, Vijayalakshmi V. Panchagavya: Boon to organic farming. India: International Book Distributing Co.; c2007.
63. Thangaroja K, Murugesh KA, Shanmugam, Bharani A. Efficacy of organic foliar formulations on the biometric and biochemical attributes of mulberry (*Morus* spp.). Trends Biosci. 2018;11(23):3152-6.
64. Tharmaraj K, Ganesh P, Sureshkumar R, Anandan A, Kolanjinathan K. A critical review on panchagavya - A boon plant growth. Int J Pharm Biol Arch. 2011;2(6):1611-4.
65. Uma Amareswari P, Sujathamma P. A study on the effect of different organic supplements on the ascorbic acid and riboflavin content of French bean (*Phaseolus vulgaris*). Int J Emerg Technol Comput Appl Sci. 2014;8(3):269-71.
66. Velmurugan M. Studies on organic farming practices on growth, yield and quality of radish (*Raphanus sativus* L.) cv. Pusachetki. South Indian Hortic. 2005;53(1-6):337-9.
67. Venkatalakshmi K, Balasubramanian A, Sankaran N. Influence of seed treatment and foliar spray of panchagavya on growth, yield attributes and yield of *Amaranthus viridae*. Madras Agric J. 2009;96(1-6):135-8.
68. Venkataramana P, Narasimhamurthy B, Krishna Rao JV, Kamble CK. Efficacy of foliar sprays of vermiwash and cow dung wash on biochemical and yield attributes and yield of mulberry (*Morus alba* L.). Karnataka J Agric Sci. 2009;22(4):921-3.
69. Vennila C, Jayanthi C. Response of okra to integrated nutrient management. J Soils Crops. 2008;18:36-40.
70. Vimalendran L, Wahab K. Effect of foliar spray of panchgavya on yield attributes and economics of baby corn. J Agron. 2013;12(2):109-12.
71. Vivek U. Effect of foliar spray of organic formulations on mulberry and its influence in silkworm, *Bombyx mori* L. [M.Sc. thesis]. Dharwad, Karnataka, India: Univ. Agric. Sci.; c2011.
72. Yamgar TD. Effect of organic fertilizers on growth of mulberry (*Morus alba* L.) and economic traits of silkworm (*Bombyx mori* L.) [Ph.D. thesis]. Parbhani, India: Marathwada Agricultural University; c2008.
73. Yogananda SB, Devakumar N, Shruti MK, Ningaraju. Growth and yield of cowpea as influenced by different sources of organic manures. In: Natnl Symp Org Agric for Sust Food Sec Challenges Opp.; c2015; Tamil Nadu, India. p. 113.