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# Production and potential of ancient liquid organics panchagavya and kunapajala to improve soil health and crop productivity: A review

**M Sharath Chandra, RK Naresh, N Lavanya, N Varsha, Shaikh Wasim Chand, Pebbeti Chandana, Shivangi, B Naveen Kumar, Rajendra Kumar and Rahul Indar Navsare**

## Abstract

During the last 5- 6 decades the indiscriminate use of agro-chemicals has adversely affected the soil fertility, crop productivity, quality of agriculture and natural products with particularly the environment. Annually India is loosing nearly 0.8 million tones of nitrogen, 1.8 millions tones of Phosphorus and 26.3 million tones of potassium (Annonymous, 2011). In India, 1% of the cropped area is organic by default as the resource poor farmers cannot purchase high cost inputs like chemical fertilizer, pesticides etc. Hence organic production systems, there is always a challenge of how to improve soil fertility, crop productivity and management of pests by organic techniques. Use of organic liquid preparations has been an age old practice in India. Vedic literatures (Vrikshayurveda) have clearly outlined a systematized agricultural practices that insisted on the use of panchagavya and kunapajala to enhance the biological efficiency of crop plants and the production of fruits and vegetables. The liquid organic manures Panchagavya and Kunapajala has a good potential as manure to improve the physical, chemical and biological properties of soil that leads to enhance the soil fertility, crop productivity and also provide food grains free from the health hazards and also used an alternative against chemical fertilizers and pesticides. Thus, Panchagavya and Kunapajala plays a major role in organic farming and sustainable agriculture. These review paper collected literature mainly emphasizes liquid organics Panchagavya and Kunapajala the need to adopt eco-friendly agricultural practices to improve soil health and crop productivity for sustainable food production.

**Keywords:** Panchagavya, kunapajala, soil health, crop productivity

## Introduction

The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable agriculture. Chemical agriculture has made an adverse impact on the healthcare of not only soil but also the beneficial soil microbial communities and the plants cultivated in these soils. This eventually has lead to a high demand for organic produce by the present day health conscious society and sporadic attempts are being made by farmers all over the world to detoxify the land by switching over to organic farming dispensing with chemical fertilizers and pesticides (Sarkar *et al*., 2014) [53].

Historically, Maharshi Vasishtha served the divine "Kamdhenu" Cow and Maharshi Dhanvantari offered to mankind a wonder medicine "Panchgavya" (a combination of cow urine, milk, dung, ghee and curd). In Sanskrit, all these five products are individually called "Gavya" and collectively termed as "Panchgavya". Panchgavya had reverence in the scripts of Vedas (divine scripts of Indian wisdom) and Vrkshyurveda (Vrksha means plants and Ayurveda means health system) (Naresh *et al*., 2018) [35]. Cow is the backbone of Indian culture and rural economy, and sustains our life; represent cattle wealth and bio-diversity. It is known as "Kamdhenu" and "Gaumata" because of its nourishing nature like mother, the giver of all providing riches to humanity and is a store of medicines The Ayurveda, the ancient Indian system of medicine, has detail mentions of importance of cow's milk, curd, ghee, urine in the treatment of various human aliments. Every product has distinct qualities and uses in health, agriculture and other fields [Chauhan, 2005; Achliya *et al*., 2004; Saxena *et al*., 2004] [16, 2, 55].

Though, chemical fertilizers increase the yield, they pose certain serious health threats to human beings especially infants, pregnant and nursing mothers (Vermeer *et al*., 1998). Another concern for health is contamination of medicinal plants with toxic heavy metals like mercury, lead, cadmium, etc., through fertilizers, harmful industrial wastes contaminating the water sources etc.

They can be absorbed into the plants and can cause disturbances in the kidneys, lungs, liver leading to several deformities like congenital paralysis, sensory neural defects and even cancer (Edward Someus, 2009; Dargan *et al*., 2008) [21, 18].

The cost of inorganic fertilizers is increasing enormously to an extent that they are out of reach of small and marginal farmers (Nileema and Sreenivasa, 2011) [40]. Combinations of plant and animal byproducts have better impacts on crop production. Liquid manures, liquid fertilizers, preparations are obtained by active fermentation of animal and plant residues over specific duration (FAO, 2006) [22] are important. Organic liquid manures play a key role in promoting growth and providing immunity to the plant system (Sreenivasa *et al*. 2010) [64]. Liquid manures are prepared by materials i.e. cow dung, urine and leaves of leguminous tree, neem leaves, fish waste, caster leaves and other medicinal plant parts. The liquid manures are used to promote the vigour and quality production. On an average, preparation of liquid manure takes 2-3 weeks. Liquid manure can also be prepared with Pongamia, Calotropis and nettle leaves, which also have insecticidal and fungicidal properties (Pathak and Ram, 2013) [44]. The Panchagavya, Jeevamruth and Beejamruth are ecofriendly organic preparations made from cow products. The use of organic liquid products such as Beejamruth, Jeevamruth and Panchagavya results in higher growth, yield and quality of crops. These liquid organic solutions are prepared from cow dung, urine, milk, curd, ghee, legume flour and jaggary. They contain macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Palekar, 2006; Natarajan, 2007; Sreenivasa *et al*., 2010) [41, 64, 36].

Organic fertilizers/organic liquid manures plays an important role in quick decomposition of organic wastes, improve humus content of the soil which is essential to maintain the activity of microorganisms and other life forms in the soil. These are prepared locally, can resolve number of apprehensions, helpful in boosting production and mitigating number of nutritional disorders in soils and crops (Pathak and Ram, 2013) [44]. Sarkar *et al*. (2014) [53] proved the efficacy of KJ and PG individually and in combination in promoting the growth and yield attributes of vegetable crops namely, tomato, chilli and cow pea. Panchagavya is an organic formulation made from cow goods. The usage of fermented organic formulations with supportive beneficial microorganisms as foliar nourishment has been come into the picture of modern agriculture for giving rise to good quality non residue protected food (Galindo *et al*., 2007) [24].

**Panchagavya preparation**

Panchagavya was prepared following the procedures outlined by Selvaraj *et al*. (2006) [56]. It contained fresh cow dung 7 kg, cow urine 10 L, cow milk 3 L, curd 2 L, ghee 1L, water 10 L, tender coconut water 3 L, Jaggery 3 kg and well ripened banana 12 number. Cow dung and ghee were mixed in an 80 L plastic container and stirred thoroughly both in morning and evening hours and kept aside for 3 days. After 3 days cow urine and water added to the mixture and kept for 15 days mixing twice every day. After 15 days the rest of the materials were added. The panchagavya was ready in 30 days after proper sieving through a fine cloth (Sarkar *et al*., 2014) [53]. Suchitra Rakesh *et al*. (2017) [67] indicated Panchagavya was prepared using the ingredients as mentioned in table 1.

**Table 1:** Ingredients involved in Panchagavya preparation (Suchitra Rakesh *et al*., 2017) [67]

| Sl. no. | Ingredients | Quantity |
|---|---|---|
| 1. | Fresh cow dung | 5 kg |
| 2. | Cow's urine | 3 litres |
| 3. | Cow's milk | 3 Cow's milk 2 litres |
| 4. | Cow's curd | 4 Cow's curd 2 litres |
| 5. | Cow's ghee | 5 Cow's ghee ½ kg |
| 6. | Jaggery | 6 Jaggery ½ kg in 3 litre of water |
| 7. | Tender Coconut water | 3 litres |
| 8. | Banana (ripe) | 12 nos |
| 9. | Toddy or grape juice | 2 litres |

**Kunapajala preparation**

Kunapajala was prepared following the procedures outlined by Nene (2012). It contained Bombay duck fish 10 kg, grind sesame oil cake 4 kg, rice husk 4 kg, molasses 4 kg and fresh cow urine 30 L. Bombay duck (Harpadon nehereus) was selected as it is cheap, devoid of scales and easy to decompose. These ingredients were taken in an 80 L plastic pot, mixed well and allowed to ferment aerobically in shade for 60 days with intermittent stirring. After 60 days, the preparation was sieved well with the help of a fine cloth (Sarkar *et al*., 2014) [53]. Thakur (2018) [70] explained the ingredients used for preparation of kanapajala in Fig 1.

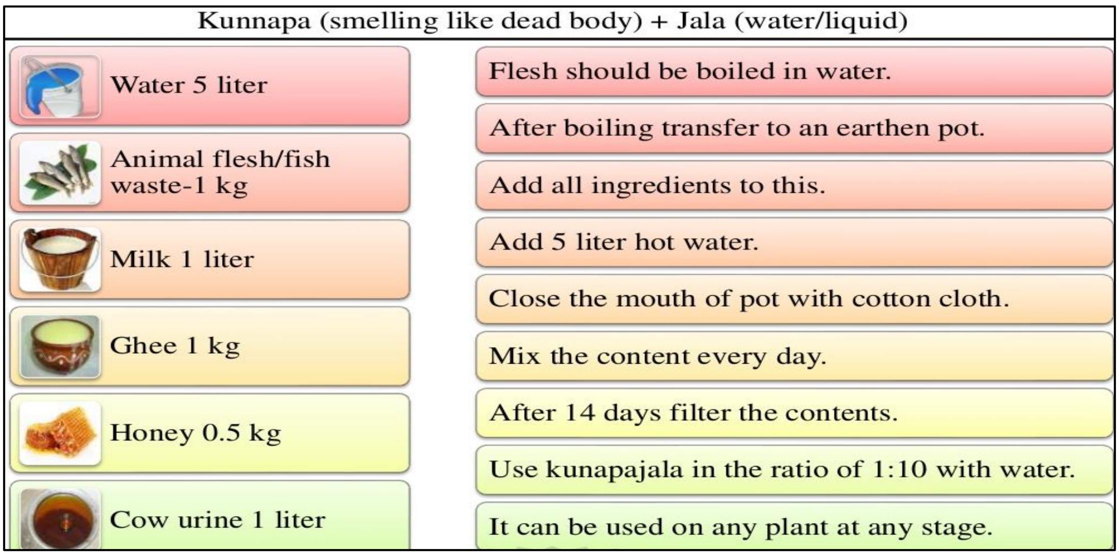


**Fig 1:** Ingredients used for preparation of Kanapajala (Source: Thakur, 2018) [70].

Kunapajala is a liquid organic manure, which is mentioned in Vrikshayurveda. At the end of the verses describing preparation of Kunapajala, it has been stated that Kunapajala is very effective and acts as plant nutrient or nourish reproductive stages of plants (Pandey, 2010) [42].

**Importance of cow in agriculture**

Livestock wealth is deemed as the oldest wealth resource for mankind. Cow represents the Vedic values of selfness service, strength, dignity and non–violence. The "Cow" occupies the highest place of honour in Indian civilization. She is supposed to fulfill all desires of human beings, hence known as "Kamdhenu". Organic farmers are need to be conveyed that it is the dung and urine which are essential component in organic farming and these are made available by cow's till her death. With small holdings and small scale farming, there is no other better alternative than involving cattle in farming system. Few decades earlier farmers had been using oxen to plough, to pick and transport harvested crops and for number of farming practices. Cow milk, curd, ghee for human health, manure as fertilizer for soil health, cow urine and butter milk for pest and diseases management used to be well established practice in each farming family. While ploughing, the oxen stride field with gentle pace, which does not harm the surface of the earth, unlike heavy machines viz; tractors and combines. While ploughing the fields, oxen defecate and urinate and thus fertilize the land. Cow thus plays a key role in all the systems of organic farming (Nane, 2003 and Pathak and Ram, 2003) [45, 33]. Vallimayil and Sekar (2012) [72] reported to Panchagavya is an organic product blended from five different cow products, commonly applied to crop plants in organic farming. It is used as foliar spray, soil application and seed treatment. It can act as growth promoter and immunity booster. Thakur (2018) [70] explains the types of organic manures in Fig 2.

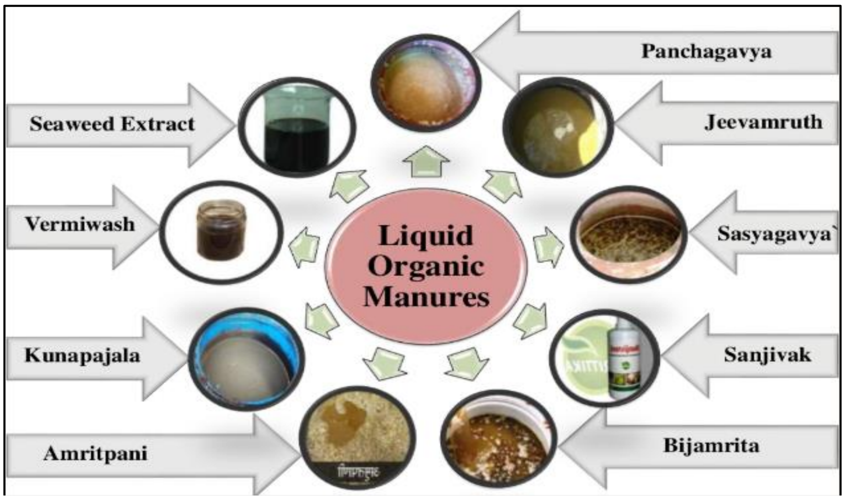


**Fig 2:** Liquid organic manures (Thakur. 2018) [70]

**Review of literature**

The present manuscript describes the effect of liquid organics Panchagavya and Kunapajala has a potential to improve soil fertility, plant health and crop productivity for sustainable food production. The application of panchagavya or Kunapajala alone and in combination of both fulfills a tremendous job in buildup of macro and micronutrient status of soil. Taking into consideration the benefit of Panchagavya, Kunapajala and its role in build-up of soil fertility and its possible effect on the enhancing the crop productivity, the review of the problem is discussed under the following heads;

**Effect of Panchagavya on soil health and crop productivity**

Panchagavya prepared from five products obtained from cow, i.e. dung, urine, milk, curd and ghee. When these are properly mixed, incubated for recommended period and ready fermented solution has miraculous effect on crops. Preparation is rich in nutrients, auxins, gibberellins, and microbial fauna and acts as tonic to enrich soil, induce plant vigour with quality production (Pathak and Ram, 2013) [44]. The Panchagavya is an efficient plant growth stimulant that enhanced the biological efficiency of crops. It is used to activate biological reactions and to protect the plants from disease incidence and he mentioned the Nutrient status of Panchagavya in Table 2 (Nileema and Sreenivasa, 2011) [40]. Amalraj *et al*., (2013) [6] reported that panchagavya application may enhance plant growth by nitrogen fixation, growth hormone production and control phytopathogens of many plantation crops.

**Table 2:** Nutrient status of Panchagavya organic liquid manures (Nileema and Sreenivasa, 2011) [40]

| Parameter | Panchagavya |
|---|---|
| pH | 6.82 |
| Soluble salt (EC) | 1.88 $dsm^{-1}$ |
| Total Nitrogen | 1000 ppm |
| Total Phosphorus | 175.40 ppm |
| Total Potassium | 194.10 ppm |
| Total Zinc | 1.27 ppm |
| Total Copper | 0.38 ppm |
| Total Iron | 29. 71 ppm |
| Total Manganese | 1.84 ppm |

Effect of panchagavya on soil fertility

- Panchagavya improves fertility status in soils by increasing macronutrients,
- Micronutrients and beneficial microorganisms thus increase soil health.
- It improves water holding capacity of soils because it acts as a organic manure.
- It encourages growth and reproduction of beneficial soil microorganisms.
- It increases nutrient uptake in plants and enhances plant growth.

- Effect of panchagavya on pest and diseases.
- It increases immunity power in plants thereby confers resistance against pest and diseases various beneficial metabolites produced by microorganisms such as organic acids, hydrogen peroxide and antibiotics, which are effective against various pathogenic microorganisms (Sivakumar, 2014) [61].

Panchagavya contains several nutrients i.e. macronutrients like nitrogen, phosphorus, potassium and micronutrients which are required for the growth and development of plants and also contains various amino acids, vitamins, growth regulators like Auxins, Gibberellins and also beneficial micro-organisms like pseudomonas, azetobacter and phosphobacteria which influenced yield of greengram (Ali *et al*., 2011). Natarajan (2007) [36] reported that the panchagavya contains macronutrients like N, P and K, essential micronutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA, which may provide nutrition to rhizosphere microorganisms and thus help to increase their population. Swaminathan *et al*. (2007) [15] reported that Panchagavya enhanced the biological efficiency of crop and the quality of fruits and vegetables production and it also increases the soil fertility. Zahir *et al*. (2003) [23] opined that micro-organisms are important component of soil environment and their large number is indicative for better soil health which improves more nutrient availability from source to sink. Thus, utilization of organic fertilizer could be better contrivance for improving biological attributes of soil which in turn may increase productivity and quality (Allen *et al*., 2012) [45] of different fruit crops. Vasanthkumar (2006) [53] and Devakumar *et al*. (2008) [20] was attributed to higher microbial load and growth harmones 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 better growth and yield of crops. Yadav and Mowade (2004) [65] reported that this increase might be due to cumulative effect of liquid organic inputs in increasing organic carbon content of soil which acted as carbon and energy source for microbes and in quick buildup of heterotrophic micro-flora and fauna. Similar results were obtained by Shwetha (2008) [79], who reported the nutrient management through organics in soybean-wheat cropping system and found that the application of organic manures supplemented with fermented organics resulted in the significant improvement of soil microbial population and enzymatic activity. Panchagavya spray influenced significantly on P-solubilizers. Spraying of 6 % recorded higher P-solubilizers (28.43, 33.04 at 60 DAT and 27.46, 34.53 at harvest during kharif and summer, respectively) and lower was recorded in without panchagavya spray (25.19, 27.85 at 60 DAT and 23.73, 23.42 at harvest during kharif and summer, respectively). The foliar spray of panchagavya might have enhanced microbial activity on the plant parts like on leaves, shoot and fruits. Additionally, the use of bio-fertilizers can improve productivity per unit area in a relatively short time with improving soil fertility as they release more amount of N, P and K (Corpoica, 2007) [17]. Improved plant growth with Panchagavya application may be due to their role in providing macro nutrients, essential micro nutrients, many vitamins, required aminoacids, growth promoting substances and beneficial microorganisms (Sivakumar, 2014) [61].

Beaulah, (2002) [10] reported that the secondary and micronutrients (Ca, S and Fe), macronutrients (NPK) contents of leaves and pods of annual moringa were superior under poultry manure + neem cake + Panchagavya treatments. Higher nutrient uptake and nutrient use efficiency in both main and ratoon crops of annual moringa were also observed. Papen *et al*., (2002) [43] reported that panchagavya contains Azotobacter, Azospirillum and phosphobacteria. Panchagavya contains microorganisms in addition to nutrients that help in improving plant growth, metabolic activities and resistance to pest and diseases. Sreenivasa, (2009) [63] revealed that Panchagavya, Beejamruth and Jeevamruth prepared by using cow products are known to contain beneficial microflora like Azospirillum, Azotobacter, phosphobacteria, Pseudomonas, lactic acid bacteria and Methylotrophs in abundant numbers and also contain some useful fungi and actinomycetes. Suchitra Rakesh *et al*., (2017) [67] revealed that panchagavya contains Azotobacter, Azospirillum and phosphobacteria. Panchagavya contains microorganisms in addition to nutrients that help in improving plant growth, metabolic activities and resistance to pest and diseases. The, Microbial load i.e., bacteria, fungi and actinomycetes was increased up to 21$^{th}$ day 110x106, 25x104 and 21x103 respectively. Effective Micro Organisms (EMO) in panchagavya were the mixed culture of naturally occurring beneficial microbes,mostly lactic acid bacteria (Lactobacillus), yeast (Saccharomyces), actinomyces (Streptomyces), photosynthetic bacteria (Rhodopseudomonas) and certain fungi (Aspergillus). The pH of panchagavya increased from 6.47 (0th day) to 6.92 (28th day). Maximum electrical conductivity was noticed on 28 $^{th}$ day (1.78 $dSm^{-1}$). The NPK content of the panchagavya 0.97, 0.92 and 0.65% was recorded maximum on 21st day after preparation respectively. Change in nutrient status and microbial load present in panchagavya are given in Table 3.

**Table 3:** Changes in Physico-chemical and biological properties of Panchagavya with time [Source: Suchitra Rakesh *et al*. 2017] [67]

| Sl. No. | Available nutrient status | | | | | Physical properties | | Microbial | load (Population Fungi (104) | = X cfu ml'') Actinomycetes (103) |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | p | K | Ca | Mg | EC (dSm-l) | pH | Bacteria (106) | | |
| 0th day | 0.18 | 0.02 | 0.24 | 0.54 | 0.81 | 0.62 | 6. | 10 | 4 | 8 |
| 7th day | 0.32 | 0.13 | 0.41 | 1. | 1. | 0.73 | 7. | 21 | 9 | 16 |
| 14th day | 0.62 | 0.12 | 0.53 | 1. | 1. | 0.98 | 7. | 38 | 14 | 18 |
| 21st day | 0.97 | 0.28 | 0.65 | 1. | 2. | 1.20 | 7. | 110 | 25 | 21 |
| 28 th day | 0.77 | 0.18 | 0.45 | 1. | 1. | 2. | 7. | 68 | 22 | 20 |

Sakhubai *et al*., (2014) [51] showed that growth parameters viz., plant height (103.10 cm) number of leaves per plant (75.62), leaf length (9.52 cm), leaf breadth (9.03 cm) recorded maximum with the application of RDF and yield parameters viz., days to 50% flowering was earlier in $T_{10}$ (VAM + Panchagavya + Amritpani (3% Drench and Spray) and $T_{11}$ (RDF (50: 40:40 kgNPK/ha, FYM-20q/ha) with 25.67DAS,herb yield recorded maximum with the application of RDF, however the organic treatment $T_{10}$ have shown on par results in growth and yield parameters in Table 4. Panchagavya found to be best in better utilisation of leaf nitrogen and efficient photosynthetic activity improving the yield (Sarkar *et al*., 2014) [53]. The significant increase in yield with these treatments is mainly attributed to significant improvement in number of pods per plant and test weight. Muthuvel (2002) [32] four sprays of Panchagavya @ 3% and Moringa leaf extract spray @ 25 ml/plant resulted in higher plant height, number of branches per plant.

**Table 4:** Growth and Yield of Buckwheat at 45 Days after sowing. (Source: Sakhubai *et al*., 2014) [51]

| Treatments | Plant Height (cm) | No. of Leaves | Leaf Length (cm) | Leaf Breadth (cm) | Days to 50% Flowering | Herb Yield (q/ha) |
|---|---|---|---|---|---|---|
| T1 - Vescicular Arbuscular Mycorrhiza (VAM - 25 kg/ha, soil application) | 81.0 | 23.0 | 7. | 7. | 29.0 | 72. |
| T2 - VAM + Panchagavya (3% Drench) | 81. | 33.0 | 7. | 7. | 29.0 | 87. |
| T3 - VAM + Panchagavya (3% Spray) | 84.0 | 47.0 | 7. | 8. | 29. | 105. |
| T4 - VAM + Panchagavya (3% Drench and Spray) | 92. | 61.0 | 8. | 8. | 30.0 | 99. |
| Ts - VAM + Amritpani (3% Drench) | 86. | 35. | 7. | 7. | 29. | 108. |
| T6 - VAM + Amritpani (3% Spray) | 82. | 42.0 | 7. | 7.0 | 30. | 112. |
| T7 - VAM + Amritpani (3% Drench and Spray) | 85. | 55. | 7. | 7. | 29. | 127. |
| T8 - VAM + Panchagavya + Amritpani (3% Drench) | 94. | 67. | 9. | 9. | 28. | 118. |
| T9 - VAM + Panchagavya + Amritpani (3% Spray) | 94. | 71. | 9. | 9. | 27. | 122. |
| Teo - VAM + Panchagavya + Amritpani (3% Drench and Spray) | 100. | 74. | 10. | 9. | 26. | 128. |
| Tii - RDF (50:40:40 kg NPK/ha, FYM-20q/ha) | 103. | 76. | 9.0 | 9. | 26. | 133. |
| Mean | 89. | 53.0 | 8. | 9.0 | 28. | 110. |
| CD 5% | 3. | 3. | 0.48 | 0.44 | 0.97 | 14. |

Rajesh *et al*. (2013) [49] opined that under different concentrations (control, 1, 3, 5, 7.5 and 10%) of Panchakavya, and all the parameters were increased in 3% concentration. Since there was increase in growth and yield at low concentration of Panchakavya, it is recommended that the Panchakavya can be used for spray after diluted properly. Panchagavya found to be best in better utilisation of leaf nitrogen and efficient photosynthetic activity improving the yield (Sarkar *et al*., 2014) [53].

Balasubramanian *et al*. (2001) [9] identified that dipping of rice seedlings in Panchagavya before transplanting enhanced the growth and yield. Reddy *et al*. (2010) reported that the higher yield levels obtained with application of biodigester liquid manures to many field crops. Similarly, Siddaram (2012) [59] reported that the increased yield levels of rice with biodigester liquid manures. Panchagavya spray influenced significantly on yield of capsicum per hectare.

Vennila and Jayanthi (2008) [75] revealed that application of 100 per cent recommended dose of fertilizer along with panchagavya spray (2%) significantly increased the number of fruits per plant, fruit weight g fruit$^{-1}$ and fruit yield q ha$^{-1}$ of okra. Mohanalakshmi and Vadivel (2008) [31] reported that application of poultry manure (5 t ha$^{-1}$) + Panchgavya (3%) in aswagandha exhibited significantly superior performance by registering the highest root yield of 1354.50 kg ha$^{-1}$. Rajasekaran and Balakrishanan (2002) [48] revealed that the Abelmoschus esculentus yield parameters were increased in 3% panchagavya spray when compared with control and other concentration. The photosynthetic pigments content such as chl. A, chl. B and carotenoid were increased in 3% panchagavya spray and decreased in control in Arachis hypogaea (Subramaniyan, 2005) [66] and Vigna radiate, Vigna mungo and Oryza sativa (Tharmaraj, 2011) [71]. Similarly application of Panchagavya at 3% on black gram recorded the highest grain yield as reported by Swaminathan *et al*. (2007) [15]. Foliar spray of Panchagavya at 3 per cent with no fertilizers was the most effective low cost technology in terms of grain yield of greengram as reported by Yadav Prakash and Tripathi, (2013) [78]. Similarly, Tharmaraj et. al. (2011) [71] observed that panchagavya application increased productivity, disease resistance in various pulses Vigna radiata, Vigna mungo, Arachis hypogea, Cyanopsis tetragonoloba. Lablab purpureus, Cicer arietinum and the cereal Oryza sativa. Swain *et al*. (2015) [68] revealed that foliar application of panchagavya at 3%concentration (30ml/lt of solution) at 10 days interval produce highest plant height (80.17 cm), early 50% flowering (44.33 days), highest number of flowers (301.73), number of fruit (169.45) and highest yield/ha (21.95 q of dry fruit) of chilli. Vimalendran and Wahab (2013) [76] reported that four sprays of three percent panchagavya at 15, 25, 35 and 45 Days After Sowing (DAS) along with 100% Recommended Dose of Fertilizers (RDF) recorded the highest fresh babycorn 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 fertilizers (7226 kg ha-1 2008 and 7262 kg ha-1 in 2009). Kanimozhi (2003) [27] revealed that application of Panchagavya at 4 per cent spray was found to be superior in respect of root yield (2.5 times kgplot$^{-1}$) when compared to control in Coleus forskohili. Shivaprasad and Chittapur (2009) [57] reported that application of panchagavya @ 3% in 10 days interval showed significantly higher yield per plant (86.95 g), yield per plot (1.220 kg) and yield per hectare (21.95 q) as compare to control. This is due to better source-sink relationship i.e. better vegetative growth, more number of flowering, more number of fruits till maturity. This might be due to hormonal effect of panchagavya along with increase in photosynthetic activity of plants which causes better source-sink relationship in chilli. Naresh *et al*. (2018) [35] revealed that Panchagavya 6 per cent spray recorded significantly higher Capsicum fruit yield (30.25, 37.49, 48.91, 118.91, 96.15, 86.29, 47.81 q ha-1 at 60, 70, 80, 90, 100, 110 and 120 DAT, respectively), N-fixers life (23.68, 25.59 at 60 DAT and 17.77, 17.18 X 103 at harvest during kharif and summer, respectively).

Gajjela and Chatterjee (2019) [23] reported that the increase in fruit length (39.78%), number of fruits per plant (9.35%), single fruit weight (23.19%), yield of fruit per plant (35.64%), plot yield (35.09%), yield of fruit (34.98%), total soluble solids (33.86%), ascorbic acid (38.74%) and protein content (14.29%) in bitter gourd was recorded in $P_3$ treatment (panchagavya 3% at 20, 40 and 60 DAS) in Fig 3. Increase in fruit weight by spray of liquid organic manures may be due to translocation of more amount of carbohydrates to developing fruits and utilization of nutrients from basal applied farm yard manure and vermicompost. Similar observation was recorded earlier by Sangeetha *et al*. [2018] in bitter gourd.

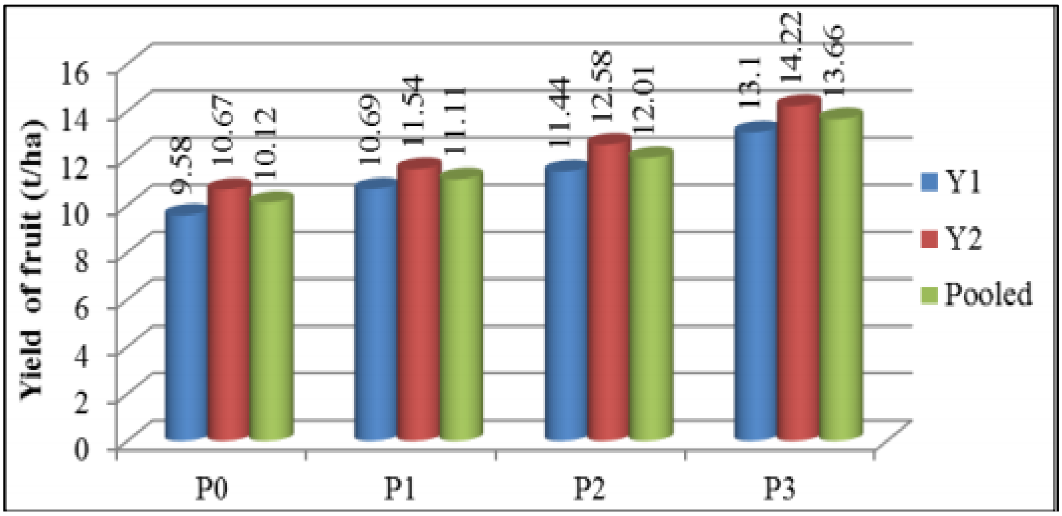


**Fig 3:** Effect of panchagavya on yield of bitter gourd fruit (t/ha) (Source: Gajjela and Chatterjee, 2019) [23]

Boraiah *et al*. (2017) [13] reported that different organic liquid formulations, application of jeevamrutha, cow urine and Panchagavya 6 per cent spray recorded significantly higher fruit yield, N-fixers and P solubilizer of Capsicum during kharif and summer respectively. Krishnaprabu (2015) [28] reported that significantly higher grain yield of greengram was recorded with foliar spray of Panchagavya (597.3 kg $ha^{-1}$) as compared to other treatments however, it was at par with foliar spray of 19:19:19 (586.7 kg $ha^{-1}$) and Jeevamruth (560.0 kg $ha^{-1}$). Similar results obtained in bengal gram (Saravanan and Panerselvam, 2014), in blackgram and greengram (Britto and Girija, 2007) and in cotton crop (Narayana *et al*., 2009) and groundnut (Ravikumar *et al*., 2012). Sau *et al*. (2017) reported that the fruit yield of tomato differed significantly with the application of liquid organic manures. The application of RDF + Beejamruth + Jeevamruth + Panchagavya resulted in significantly higher fruit yield of plants as compared to application of Beejamruth + Jeevamruth + Panchagavya due to adequate supply of required nutrients through chemical fertilizers at early stage of plant growth and also due to overall improvement in soil physico-chemical and biological properties due to combined application of organic liquid manures. The better nutrient availability and nutrient uptake increased the growth and yield of crop. The positive effect of panchagavya on growth and productivity of crops has been reviewed and documented by Somasundaram and Amanullah (2007)

Swaminathan *et al*. (2007) concluded that panchagavya as an organic growth-promoter for small and marginal vegetable growers (Boomathi, 2006). The cost-benefit to farmers was greatest when Panchagavya was used as a growth promoter and proved as the cheapest and Higher net returns and B: C ratio were evidenced when panchagavya was included in the nutrient management strategies in crops like rice, green gram, and black gram.

### Effect of kunapajala on soil health and crop productivity

Vedic literature provides some of the earliest written record of liquid organic manures like Kunapajala and Shasyagavya and their applications in ancient India. The name Kunapajala (water with smell of corpse) came from the Sanskrit words 'Kunapa' means corpse and 'Jala' means water. This liquid manure is prepared by mixing cow dung, cow urine, animal waste (flesh, marrow, etc.), and water in 1:1:1:2 ratios, respectively. Kunapajala is a fermentation product using easily available ingredients like Sesamum indicum L. (Tila), bone marrow, flesh (sheep, goat, fish etc), milk, black gram (Vigna mungo), ghee, honey etc. The beauty of kunapajala is that, it can be used on any plant at any growth stage (Naresh *et al*., 2018) [35].

Preparation of Kunapajala is an age old practice of organic liquid preparations. It involves boiling of flesh, fat and marrow of animals such as deer, pig, fish, sheep, goat in water, placing it in earthen pot, and adding milk, powders of sesame oil cake, black gram boiled in honey, decoction of pulses, ghee and hot water used to be the common booster of plant vigour (Nene, 2007). This fermented liquid manure is called as Kunapajala. It is sprayed on plant to enhance its vigour and production.

Kunapajala, a liquid bio fertilizer is a natural organic product derived from animal and plant products containing a significant quantity of one or more of the primary nutrients like Nitrogen, Phosphorus, and Potassium which are necessary for plant growth. Oil cakes, blood meal, fish manure etc are said to be concentrated organic manures. These are also known as organic nitrogen fertilizers. Before their organic nitrogen is used by the crops, it is converted through bacterial action into readily usable ammoniacal nitrogen and nitrate nitrogen. These organic fertilizers are, therefore, relatively slow acting, but they supply available nitrogen for a longer period (Neff *et al*., 2003). Chakraborty *et al*. (2019) reported the macro and micro nutrient content of Kunapajala and Physical and physico-chemical parameters of Kunapajala was mentioned in Table 5 & 6.

**Table 5:** Macro and micro nutrient content of Kunapajala (Source: Chakraborty *et al*., 2019).

| Parameters | Kunapajala | | |
|---|---|---|---|
| | On the day of preparation (0 days) | 20 days after preparation | 40 days after preparation |
| N $mg/dm^3$ | 3486 | 7238 | 4690 |
| P $mg/dm^3$ | 208.661 | 296.26 | 517.717 |
| K $mg/dm^3$ | 890.396 | 1589.994 | 1873.543 |
| Ca (mg/l) | 376 | 452 | 614 |
| Mg (mg/l) | 56 | 73 | 88 |
| S (mg/l) | 678 | 857 | 719 |
| Fe (mg/l) | 55 | 67 | 72 |
| Zn (mg/l) | 6.78 | 13.63 | 17.75 |
| Cu (mg/l) | 4.76 | 7.44 | 8.53 |
| Mn (mg/l) | 0.58 | 1.27 | 2.06 |

**Table 6**: Physical and physico-chemical parameters of Kunapajala (Source: Chakraborty *et al*., 2019)

| Parameters | On the day of preparation (0 days) | 20 days after preparation | 40 days after preparation |
|---|---|---|---|
| Colour | Light brownish orange | Brownish orange | Dark brownish orange |
| Odour | Mild alcoholic smell | Foul alcoholic smell | Extreme foul alcoholic smell |
| Mould growth | No mould growth | Heavy mould growth | No mould growth |
| Maggot Population | No maggot found | Heavy maggot growth | No maggot found |
| pH | 6.74 | 3.47 | 8.81 |
| EC (ds/m) | 2.55 | 9.72 | 8.57 |

Shasyagavya (shasya means plant product and gavya means obtained from cow) is the fermented mixture of cow dung, cow urine, vegetables waste, and water in 1:1:1:2 ratios, respectively. It is generally prepared by chopping and fermenting weeds in water along with cow dung. The product is mixed thoroughly by continuous stirring, strained, and used for soil drenching in tea or as a foliar spray (Naresh *et al*. 2018) [35]. Kumar *et al*. (2001) and Singh *et al*. (2004) remarked that the attainment of biomass was significantly and positively correlated with seed yield. The kunapajala ($T^{-3}$) treatment was effective in enhancing the morphological parameters of the leaves of tomato plant followed by conventional farming ($T^{-1}$) and organic farming ($T^{-2}$). Relative water content (RWC) and osmotic potential (OP) of cell sap showed maximum increase under the influence of $T^{-3}$ (30 % and 26 % respectively), as against $T^{-1}$ (8 % and 26 % respectively) and $T^{-2}$ (12 % and 6 % respectively) compared to the control (without any treatment).

Mishra (2007) studied the growth of paddy using Kunapajala for every 10 days showed significant increase in growth parameters like plant height, leaf length, inflorescence length, number of grains per inflorescence etc. Bhat Ramesh and Vasanthi (2008) reported that the application of Kunapajala in Brinjal shows large number of branches, higher yield, fruits with lesser seeds and lower susceptibility to diseases when compared with plants grown with artificial fertilizer. Patil (2007) mentioned that there is always a danger of passing on dormant pathogen to fields with plant based compost. But this is avoided by kunapajala because the kunapajala ingredients are cooked and fermented. So, it is concluded that the use of kunapajala enhances vegetative growth which leads to better yield with increased disease resistance under organic farming condition. Mishra (2007) pointed out that kunapajala can be a good substitute to synthetic fertilizers.

Ali *et al*. (2012) reported that black gram, Shasyagavya @ 20 and 10% spray and Kunapajala @ 5 and 10% spray produced better yields whereas highest yield was recorded with Shasyagavya 20% (0.11 kg $m^{-1}$). In mustard, the only yield indicator which significantly varied among the treatments was 1000 seed weight. The average 1,000 seed weight was maximum (2.56 g) with Shasyagavya 10% spray and minimum (1.5 g) in control. Notably, Kunapajala 3% spray exhibited better result for most of the characters as compared to other treatments in mustard. Asha (2006) [8] showed that Kunapajala treated Langali (Gloriosa superba Linn) plants exhibited excellent result in terms of general growth of the plants and fruiting when compared to control group and chemical fertilizer group.

Ankad *et al.* (2017) [7] conducted experiment to study the effect of KJ and PG in comparison with control, organic (farmyard manure and humic acid) and inorganic (NPK) fertilizer at 60, 90, 120 and 150 days after sowing (DAS). He concluded that KJ group were higher in, total leaf area (1707.89 $cm^2$) at 120 DAS, leaf area index (3.795) at 120 DAS, crop growth rate (0.256 g $m^{-2}$ $day^{-1}$) at 60-90 DAS, leaf area duration (101.909) at 120-150 DAS, relative growth rate (0.0170 g $g^{-1}$ $day^{-1}$) at 60-90 DAS, net assimilation rate (0.0537 g $m^{-2}$ $day^{-1}$) at 60-90 DAS. Leaf area ratio was higher in PG group (37.937 $m^{-2}$ $g^{-1}$) at 60 DAS. The higher levels of chlorophyll a, b and carotenoids were in KJ group (1.877, 0.745 and 1318.14 mg $g^{-1}$ respectively) at 90 DAS. The quality of yield was assessed on the basis of root length and diameter. Yield and quality attributes at harvest (150 DAS) indicated, higher dry root yield (5.93 quintal $hectare^{-1}$), root length (15.66 cm) were higher in KJ group and root diameter was higher in PG group (1.36 cm) in Table (7& 8).

**Table 7**: Growth attributes of Withania somnifera Dun at different growth intervals at 60; 90; 120; 150: days after sowing [Source: Ankad *et al*. (2017)] [7].

| Treatment n = 4 | Height of the plant (cm) | | | | No. of leaves per plant | | | | No. of branches per plant | | | | Total leaf area (cm2) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60 | 90 | 120 | 150 | 60 | 90 | 120 | 150 | 60 | 90 | 120 | 150 | 60 | 90 | 120 | 150 |
| Contr | 16. | 31.50 | 41.40 | 42. | 21. | 55.00 | 85.00 | 65. | 1. | 5.00 | 7.00 | 6. | 451. | 1113. | 1581. | 1188. |
| KJ | 17. | 38.00 | 44. | 45. | 21.50 | 65. | 92. | 68. | 1. | 6.00 | 8.00 | 7. | 517. | 1254. | 1708. | 1349. |
| PG | 17. | 35.50 | 44.10 | 43. | 22. | 66.50 | 92.50 | 68. | 1.50 | 6.50 | 8. | 7.00 | 507. | 1216. | 1682. | 1306. |
| FYM | 15.50 | 32. | 42.10 | 42. | 18. | 55. | 93.50 | 70. | 1.00 | 5.50 | 7. | 6.50 | 464. | 1139. | 1594. | 1217. |
| NPK | 17. | 34.00 | 44. | 44. | 22.00 | 65.50 | 94. | 69.00 | 1.50 | 7. | 8.00 | 7. | 494.90 | 1189. | 1664. | 1279. |
| HA | 16. | 31. | 42. | 42. | 20. | 6525 | 91.50 | 67. | 1. | 625 | 7. | 6.50 | 478. | 1067.80 | 1615. | 1153. |
| SEm ± | 0.59 | 2. | 1. | 1. | 1. | 4. | 3. | 3. | 0.22 | 0.73 | 0.61 | 0.61 | 16. | 24. | 9. | 24. |
| CD at 5% | 2. | 6. | 4. | 3. | 4. | 12. | 7.60 | 8. | 0.65 | 2.20 | 2. | 2. | 47. | 71. | 26. | 71. |
| CV% | 7.20 | 11. | 6. | 5. | 14. | 13. | 6. | 8. | 33.40 | 24. | 16. | 18. | 6. | 4. | 1. | 4. |

**Table 8:** Yield and quality of Withania somnifera Dun at harvest (150 DAS) [Source: Ankad *et al*. (2017)] [7].

| Treatment n = 4 | Dry root yield | | Root length (cm) | Root diameter (cm) |
|---|---|---|---|---|
| | g plot$^{-1}$ | q hect$^{-1}$ | | |
| Contr | 92.40 | 4.62 | 13.98 | 1.17 |
| KJ | 118.63 | 5.93 | 15.66 | 1.26 |
| PG | 116.41 | 5.82 | 15.56 | 1.36 |
| FYM | 95.44 | 4.77 | 14.98 | 1.2 |
| NPK | 108.65 | 5.43 | 14.31 | 1.28 |
| HA | 107.88 | 5.39 | 14.85 | 1.19 |
| SEm ± | 4.13 | 0.21 | 0.53 | 0.05 |
| CD at 5% | 12.44 | 0.62 | 1.59 | 0.16 |
| CV% | 7.74 | 7.74 | 7.10 | 8.57 |

Contr: Control; KJ: Kunapa jala; PG: Pancha gavya; Fym: Farmyard manure; NPK: Inorganic fertilizer; HA: Humic acid; g: gram; q: quintal; hect: hectare; SE m: Standard error of mean; CD: Critical difference; CV: Coefficient of variation.

Hasanuzzaman *et al*. (2008) [25] opined that an increased trend of plant weight was observed with the increase of cow dung amount due to the beneficial effect of organic matter in soil properties and plant growth. Similar trends were observed in KJ and PG groups.

Application of kunapajala (T$^{-3}$) treatment was effective in enhancing the morphological parameters of the leaves of tomato plant followed by conventional farming (T$^{-1}$) and organic farming (T$^{-2}$) (Naresh *et al*., 2018) [35]. Deshmukh *et al*. (2012) [19] revealed that kunapajala treatment is superior to conventional farming and organic farming as it brings about physiological, biochemical and enzymatic enhancement in the leaves of tomato under organic farming conditions.

Narayanan (2006) [34] revealed that improved modifications in the preparation of Kunapajala by mixing Panchagavya show tremendous results when applied to vegetables. Panchagavya, Matka Khad, Vermiwash and Jeevamrti as foliar were also proved quite effective in enhancing the productivity of different crops and effective against various plant pathogens.

Jani *et al*. (2017) [26] revealed that Kunapajala is in liquid state which provides a higher absorption for plants compared to that of traditionally applied solid organic manure. Composting Kunapajala helps in breaking down the manure into simpler forms, making it available to plants faster than the traditionally applied organic matter. Also compost nutrients are released slowly, allowing them to stay in the soil for a longer period enhancing microbial action in the soil, allowing it to absorb and retain water and nutrients more efficiently. Being a liquid it is readily available for the roots in a short time (Prabha *et al*., 2008) [47].

Ankad *et al*. (2017) [7] reported that the germination parameters of Ashwagandha and Kalamegha seeds in KJ and PG along with control, FYM, HA and NPK treatment. He concluded that at the end of 30th day, root length (Fig. 4a) and shoot length (Fig. 4b) were recorded. In Ashwagandha highest root length was observed in NPK group (3.17 ± 0.13 cm) followed by KJ (3.13 ± 0.17 cm). Similarly in Kalamegha, highest root length was observed in NPK group (3.00 ± 0.14 cm) followed by KJ (2.97 ± 0.17 cm). Results of shoot length indicated, highest shoot length in Ashwagandha was observed in NPK group (2.57 ± 0.97 cm) followed by KJ (2.54 ± 0.95 cm). Similarly in Kalamegha highest shoot length was observed in NPK group (3.37 ± 1.04 cm) followed by KJ (3.30 ± 1.04 cm).

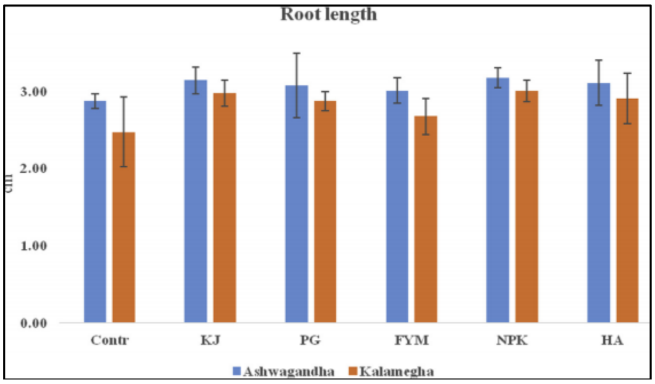


**Fig 4(a):** Root length

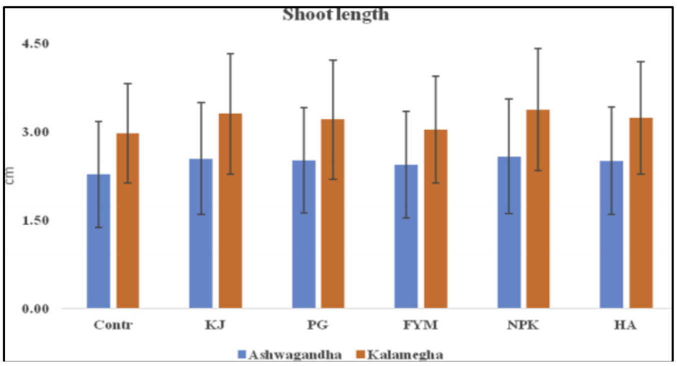


**Fig 4(b):** Shoot length

**Interaction effect of Panchagavya and kunapajala on soil health and crop productivity**

Sarkar *et al*. (2014) [53] reported that both panchagavya and kunapajala increased the linear growth of both shoot and root systems in all the vegetable seedlings compared to respective controls (Figs. 5a & 5b). Enhancement in the growth of root and shoot systems in the experimental crops was more pronounced in seedlings grown in soil drenched with combination of panchagavya + kunapajala (T3) rather than with panchagavya or kunapajala alone. Shoots of the tomato seedlings grown with combination of panchagavya + kunapajala exhibited 23.21% more growth than that of the control plants. In chili, the percent increase in the linear growth of shoots over control plants with different treatments was relatively low in the range of only 5 – 15% as compared to cow pea, in which it was 10 – 23%. Linear growth of root in the experimental plants too exhibited a similar response to treatment with combination product (Fig. 5b). In $T_3$, about 50% increase in the linear growth of root could be observed in all the three vegetables as compared to controls. Panchagavya ($T_1$) and kunapajala ($T_2$) individually also showed a significant positive response over the control. In tomato, the lamina size was nearly 51.13% larger with kunapajala followed by panchagavya + kunapajala (39.95 %). Per cent increase over control in the leaf area of the seedlings of tomato, chili and cow pea grown in soil drenched with fish emulsion was 51%, 10% and 30%, respectively (Fig. 6a). The plant weight and root weight are indicators of biomass accumulation by any plant. All the vegetable seedlings showed a significantly better performance in biomass production against each of the treatment over control. Plant weight was increased as high as 106.63% in tomato treated with kunapajala (Fig. 6b). Though, a constant superiority of a single treatment was lacking. In case of root weight of seedlings $T_3$ (panchagavya + kunapajala) recorded a clear superiority over the other treatments in all the three vegetables.

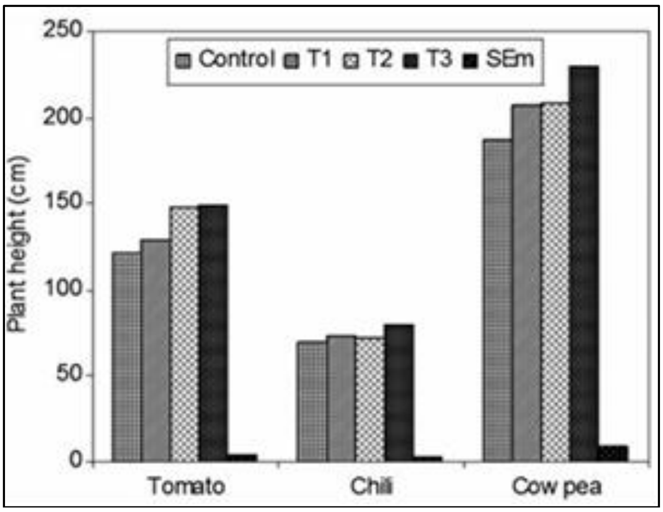


**Fig 5(a):** Effect of liquid organics on plant height of vegetable seedlings

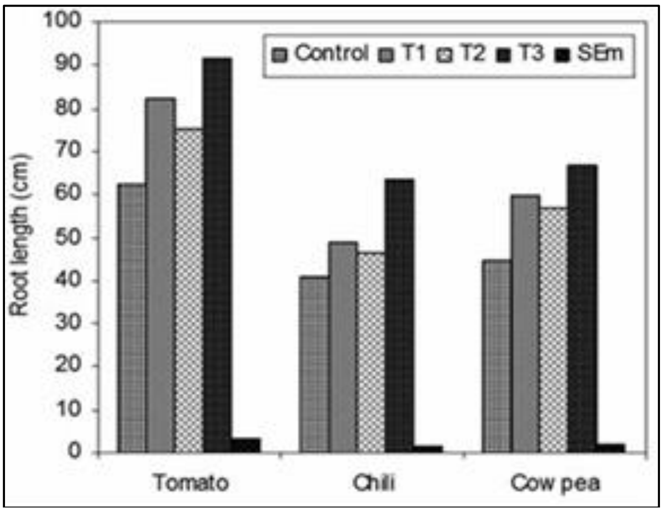


**Fig 5(b):** Effect of liquid organics on root length of vegetable seedling

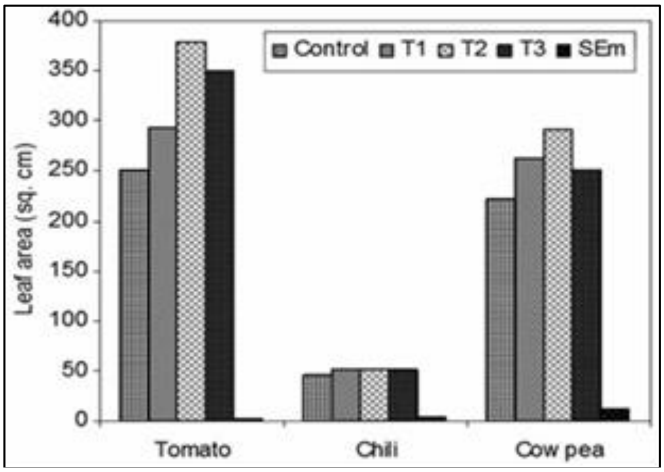


**Fig 6(a):** Effect of liquid organics on leaf area of vegetable seedlings

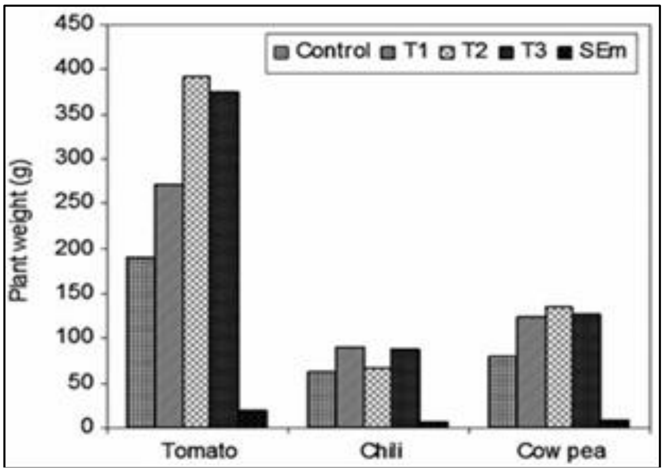


**Fig 6(b):** Effect of liquid organics on plant weight of vegetable seedlings

Sarkar *et al*. (2014) [53] also revealed that number of fruits plant$^{-1}$ and fruit yield plant$^{-1}$ in all the three treatments showed better performances over control. Fruit number was increased as high as 107% in chili treated with panchagavya + kunapajala (Fig. 7a). $T_3$ (panchagavya + kunapajala) also recorded a clear superiority over the other treatments in all the three vegetables for increasing fruit yield (Fig. 7b). It ranged from 115% increased fruit yield in tomato to 127% in cow pea over their respective control. Panchagavya ($T_1$) and kunapajala ($T_2$) individually also contributed significantly in enhancement of fruit number and yield in all these crops.

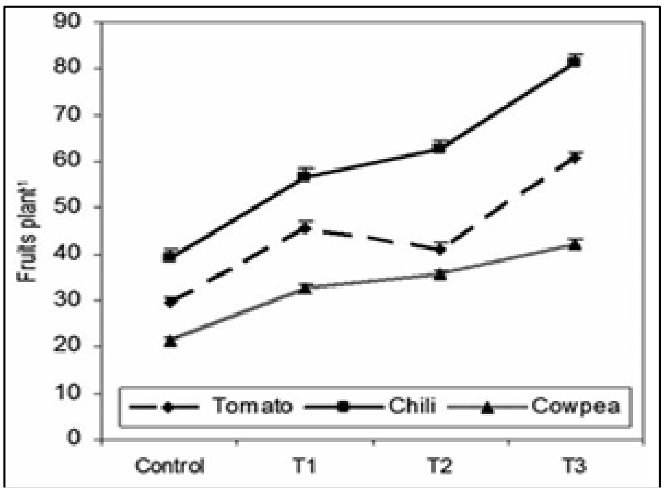


**Fig 7(a):** Effect of liquid organics on fruits plant$^{-1}$ of vegetables

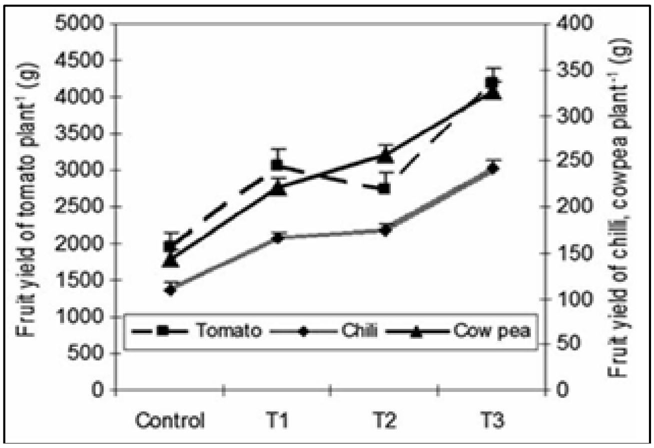


**Fig 7(b):** Effect of liquid organics on fruits yield plant-1 of vegetables

## Conclusion

In the modern day's agriculture with the increase in organic inputs in the farming of high value crops use of such growth promoters through soil drenching and foliar spraying will be efficient and economical choice for the farming community. Organic management practices have the potential to upkeep the soil health as well as sustain the crop yield over a longer period of time. By the use of liquid organics Panchagavya and Kunapajala proved beneficial in different crops and produced better growth of plants and crop productivity to increase sustainable production. The organic nutrients which are interfered with healthier agriculture for the betterment of life; the organic nutrient source such as liquid organics Panchagavya and Kunapajala which are playing very important role in the healthier crop production system.

The liquid organics Panchagavya and Kunapajala has potential to improve soil fertility, crop productivity and quality for sustainable agriculture production, health and nutrition of humans, production of bio-fertilizers production of nonconventional energy and for maintaining the bio-diversity of the ecosystem. Panchagavya and Kunapajala by virtue of its behavior as plant growth regulator is readily available as a simple compost manure showing its potency in increasing the leaf area, higher yield of flowers and fruits as well as phyto-constituents. It also seems that Panchagavya and Kunapajala has some plant growth regulatory actions through which it enhances the overall growth of plants. Being a liquid bio-fertilizer it is a more suitable form of manure and can be beneficial in growth of medicinal plants with probably minimal toxic effects on human body when compared to chemical fertilizer. All these traditional agricultural inputs hold good promise for use in agriculture and production of safe and healthy food.

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