DISCUSSION

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Agriculture is the fore most occupation which forms the basis for the life of human and for other various industrial endeavors. The world population is dependent on agriculture either directly or indirectly. Inorganic fertilizer and pesticides boosted the crop yield in the previous century and the indiscriminate use of them resulted in environmental issues. As a result the agricultural practice is reverting back to organic methods and panchakavya gets a renounced place due to its efficiency. Panchakavya proves to enhance crop yield irrespective of the crop, which means they could be used evenly for any plant. Further, they act both as a fertilizer and pesticide and shows growth promoting properties. In the present study the effect of panchakavya and other organic adjuvants on growth and yield was studied in 4 different crops namely ragi, green gram, paddy and roselle. Six different treatments namely panchakavya, panchakavya + plants, panchakavya + animal waste, panchakavya + neem cake and vermicompost were compared with control and chemical fertilizer.

Eco-friendly agriculture has been a new trend to ensure sustainable productivity and conserve environmental quality of soil, water, reduce pollution, recycle organic resources, and produce safe foods, increase yields. Chemicals have been dumped continuously over years and have made the land less fertile, leading to yield losses. Bio-fertilizers have become an ideal substitute for chemical fertilizers for conditioning the soil fertility and to maintain the agro-ecosystem (Prabu, 2008).

In the present study the effect of panchakavya as an aerial spray to enhance the growth and yield of crops was studied on four different crops namely ragi, green gram, paddy and roselle. Panchakavya with three different adjuvants were also prepared and used in the present investigation. Panchakavya, panchakavya + plants, panchakavya + animal waste and panchakavya + neem cake were compared with vermicompost, chemical fertilizer and control.

The yield in all four crops namely ragi, green gram, paddy and roselle were found to increase in panchakavya + animal waste spray when compared with control and other treatments. The yield was nearly 4 times than that of control and two times than that of chemicals in all the four crops.

The present investigation was hypothesized to examine the effect of panchakavya on seed germination in four crops namely ragi, green gram, paddy and roselle. Among the panchakavya preparations, the panchakavya + animal waste treated seeds showed maximum germination frequency and seedling vigour when compared to control and other treatments. All the panchakavya treatments showed increased germination frequency and seedling vigour but panchakavya + animal waste was the best preparation. Ramya and Karpagam (2017) reported that panchakavya has a favourable effect on seed germination and growth of vegetable crops. Sangeetha and Thevanathan (2010) studied the potential of panchagavya as bio-fertilizer against certain pulses by growing in soil amended with seaweed extract and panchagavya. Experimental seedling recorded higher rates of linear growth of both shoots and roots as compared to

controls. These seedlings produced 264 to 390% more lateral roots than the control and maximum lateral root production was always observed in seedlings grown in soil amended with seaweed based panchagavya at low concentrations. Leafy vegetables require more nitrogen than other vegetable crops hence the need for adequate nitrogen fertilization. The Panchagavya increases the total biomass, leaf quality, mineral, vitamin and carbohydrate content in *Spinacia oleracea* (Shailaja *et al.,* 2014).

The liquid cattle manure applied to soil did not affect the seed germination but resulted in a significant increase in plant height, number of green leaves and dry biomass of maize relative to control and was similar to that of fertilizer treatment. Organic manures can improve soil-water-plant relations through modifying bulk density, total porosity, soil water relation and consequently, increasing plant growth and water use efficiency.

Panchakavya, panchakavya + plants, panchakavya + neem cake and vermicompost increased the yield in all the four crops, whereas the panchakavya + animal waste was the most effective to enhance the plant growth and yield.

Similar adjuvants were used previously by other workers like biogas slurry with panchakavya combination was adjudged as the best organic nutrition practice that increased the growth, productivity, quality of crops, soil health and economy of maize, sunflower, green gram (Somasundaram *et al*., 2007). Similar findings were observed in *Vigna mungo* and *Oryza sativa* (Rajesekaran and Balakrishanan, 2002), black gram, green gram (Brito and Girija, 2006) and ground nut

(Ravikumar, 2012). Panchakavya was tested for different crop such as turmeric, paddy, onion, gingelly, sugarcane, banana, vegetables and curry leaves and it was found that it enhanced the growth vigour of crops, resistance to pest and disease and improvement of keeping quality of vegetables and fruits.

After the crops were harvested soil was analyzed for macronutrients and micronutrients. The panchakavya treated soil was seen to have increased in the soil fertility. The macro and micronutrient content was more in panchakavya treated soil than that of control and chemical fertilizers treated soil. Microbial flora of soil plays on important role in soil health. The microorganism present in the rhizosphere environment around the root influence the plant growth and crop yield. The beneficial microorganism from panchakavya and their establishment in the soil improved the sustainability of agriculture (Tharmaraj *et al.*, 2011).

In India panchakavya, farmyard manure form the integral components of nutrient management in practice within organic farming systems. Panchakavya has been shown to increase plant production and also has been shown to beneficial effects on a variety of crops (Natarajan 2002). Though panchakavya are used in practice, meager reports are available on their microbial quality (Leo Daniel Amal Raj *et al*., 2013)

On the other hand panchakavya is a single organic input, which can act as growth promoter and immunity booster. It has significant role in providing resistance to pest and diseases and in increasing the yield and shelf life (Sendhilnathan *et al*., 2017).

The foliar spray of panchagavya induces a better defense mechanism in the plants (Sangeetha and Thevanathan, 2010) that decreased the pathological conditions and this could be construed as a positive aspect of panchagavya in promoting the yield potential of crop plants.

Plants sprayed with panchagavya invariably produce bigger leaves and develop denser canopy (Somasundaram *et al*., 2007; Tharmaraj *et al*., 2011). The photosynthetic system is activated for enhanced biological efficiency, enabling synthesis of maximum metabolites and photosynthesis. Adding panchagavya during the composting process helps to improve the quality of compost. Using panchagavya also helps to increase the yield and quality of the products (Subramanian 2005). Compared to chemical fertilizers, this is less expensive and more ecofriendly with no side effects.

The panchakavya + animal waste reduced the fungal infections and pests on the plants when compared to control and chemicals. The disease incidence was comparatively lesser in panchakavya treatments and vermicompost when compare to control and chemical. Similar finding were observed in *Moringa* (Vivekananda, 1999). Boomiraj *et. al*. (2004) reported that panchagavya was effective against leaf hopper (*Amrasca biguttula*) and white fly, (*Bemisia tabacci*). Panchagavya controls *Spodoptera litura* larvae (Bharathi, 2005). Whereas, Neelakanth (2006) noted that panchagavya + cow urine proved the best in controlling *Plutella xylostella* in cabbage and shoot fly in sorghum (Mudigora *et al.* 2009). Panchagavya reduced mosaic virus when applied as foliar spray in plants (Vallimayil and Sekar, 2012).

The present investigation increased soil fertility in panchakavya + animal waste treatment. Panchakavya, panchakavya + plants, panchakavya + neem cake and vermicompost showed a slight difference, whereas the panchakavya + animal waste was the best to enhance the plant growth and yield. Similar finding was observed by Swaminathan *et al. (*2007) where panchagavya was found to increase the quality of fruits and vegetables production, and also increases the soil fertility.

Panchakavya can be used either as a foliar spray or as liquid fertilizer after dilution while the pest repellent character is the best when can be sprayed over the plants. Panchakavya increase yield and boost immunity and is also an organic pesticide (Seetha Gopalakrishnan, 2013). The Vriskhayurveda systematizes the use of panchakavya; few farmers in the southern parts of India have used modified formulations of panchakavya and found then to enhance the biological efficiency of the crop plants and the quality of fruits and vegetables (Natarajan, 2002). The use of fermented liquid organic fertilizers and the presence of effective microorganisms as foliar spray have been proved to improve food products with good quality and safety (Galindo *et al*., 2007). Role of foliar applied panchakavya in the production of many plantation crops had been well documented in India (Selvaraj, 2003).

The number of new methods of recycling and controlling measures of organic waste in urban and rural habits was proposed by many strategists (Furedy and Blumantal *et al.,* 1989). The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable

agriculture. Chemical input had an adverse impact on the health-care of not only soil but also the beneficial soil microbial communities and the crops. This eventually led to a high demand for organic products. The increase in plant height might be due to the application of nutrients through foliar spray of panchagavya which enhanced the growth rate of plant since it contains the favorable macro and micronutrients, growth hormones and bio-fertilizers in liquid formulation.

In the present investigation the growth promoting capacity of panchakavya and the adjuvants were studied in onion bulbs. It was found out that at 1% concentration the panchakavya formulations enhances the rooting in onion bulbs and also increases the cell division as observed from the increased mitotic index rate. IAA was estimated in higher quantities in panchakavya + animal waste sample, and it was also present in slightly lesser quantities in other panchakavya preparations.

Moreover the presence of growth enzymes in panchagavya might have favoured rapid cell division and elongation. Similar findings have been reported by Venkatlakshmi *et al.* (2009), Balakumbahan *et al*. (2010) and Kumar *et al*. (2011). Yield of chickpea was significantly influenced by foliar spray of panchakavya at the concentration of 4% at branching + flowering stage recorded the maximum seed yield. This might be attributed to the favorable effect on vegetative growth, i.e. plant height and reproductive growth parameters. These findings are in line with those reported by Kumawat *et al.* (2009) Avudaithai *et al.* (2010) and Suresh *et al*., (2011).

The present study revealed higher concentration of IAA in panchakavya + animal waste. Though all the panchakavya treatments showed IAA, panchakavya + animal waste has the maximum concentration which accounts for its enhanced growth promoting ability. When the panchakavya was given as a foliar spray, the nutrients are easily transferred to the plants which contain considerable quantities of IAA and GA in it (Kunnal, 1997, Ravi Kumar, 2012).

The IAA and GA present in panchagavya when applied as foliar spray could have created stimuli in the plant system and increased the production of growth regulators in cell system and the action of growth regulators in plant system ultimately stimulated the necessary growth and development (Patel, 2012). Growth regulatory substances such as Indole Acetic Acid (IAA), Gibberellic Acid (GA3), Cytokinin and essential plant nutrients from panchakavya (Perumal *et al.,* 2006) caused a tremendous influence on the growth rate in *Allium cepa* and panchagavya at 30 days of age recorded better proposition of chemical and microbial composition favourable for utilization as a growth promoter and panchagavya did not have direct antibacterial activity (Mathivanan *et al*., 2006).

The positive effect of panchagavya on growth and productivity of crops has been reviewed and documented by Somasundaram and Amanullah (2007). The presence of auxin in panchagavya controls the water regulation in developing fruits of okra. Regular and uniform water supply to the developing fruits resulted in increased ascorbic acid content, Barletts index and crude

protein content (Vennila and Jayanthi, 2008). Panchagavya is known to contain growth regulatory substances such as IAA, GA and cytokinin. Significant improvement in the growth and nutrient content of *Vitis vinifera* was observed using panchagavya along with microbial fertigation (Geetha and Aruna, 2013).

The enhanced growth may be due to the presence of growth regulatory substances such as IAA, GA, cytokinin, essential plant nutrients, effective microorganisms and bio-fertilizers like *Acetobacter*, *Azosprillum* and *Phosphobacterium* present in panchagavya and vermiwash (Esakkiammal *et al.,* 2015; Somasundram *et al.,* 2004, Papen *et al.,* 2002).

Sreenivasa *et al.* (2011) have observed mostly nitrogen fixers and P-solubilizers in four different organic liquid manures such as panchagavya, beejamrutha, jeevamrutha and biodigester. Presence of naturally occurring beneficial microorganisms predominantly bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi were detected in organic liquid manures (Swaminathan, 2005).

Xu (2001) reported that effective microorganism cultures could synthesize phytohormones i.e., auxins and other growth regulators that stimulated maize plant growth and they contained proactive substances that could significantly affect leaf stomatal response in maize. Leaf stomata of the treated maize opened more rapidly than water treated control plants and when leaves were subjected to dehydration, the stomata closed more slowly (i.e., remained open longer) thus showed that, effective microorganism contained

bioactive substances that could have significantly affected leaf stomata response.

The present study revealed the growth promoting efficacy of panchakavaya that favors cell growth, cell division which is known from the mitotic index studied in onion bulbs. The onion bulbs produced longer roots and shoots when compare to control. The presence of growth promoting substance present in the panchakavya + animal waste favored the rooting. The effect of adjuvants namely vermicompost and neem cake showed a slight difference, whereas the panchakavya alone was sufficient to enhance the seed germination. The present study reveals that panchakavya preparation is easy and it is cost effective and could be prepared easily by a farmer with his household expenses and availability. Rahul kumar *et al*. (2014) studied the effect of panchakavya fortified with *Bauhinia* plant extract which showed a positive response as an anthelminthic preparation.

Several microbiological techniques performed for the identification of bacteria and fungi present in panchakavya. The enzymes released by bacteria convert the complex insoluble organic compounds to simple soluble form. This may be helpful for plants to uptake nutrients through the action of these microorganisms that are enzymatically active.

Some of the problems encountered by Spinach growers include decreasing soil fertility and quantity of manure required for optimum crop productivity (Lucas and Ojeifo, 1985; Adeyemi *et al*., 1987). Inadequate supply of chemical fertilizer and lack of capital to buy them, lead to organic

farming whose main focus is on farmyard manure (Adeyemi *et al*., 1987; Olufolaji *et al*., 1990; Olufolaji *et al*., 1999). To increase the availability of high quality greens throughout the year at reduced price, there is a need to use organic manures in large quantity.

Effective microorganisms can improve soil quality, growth and yield of crops by synthesizing phytohormones such as auxins and other growth regulators that might have simulated the growth of plants (Xu *et al*., 2000). Presence of naturally occurring beneficial and effective microorganisms predominantly lactic acid bacteria, yeast, Actinomycetes, photosynthetic bacteria and certain fungi were improved with panchakavya treatment. It is a mixed culture of naturally occurring, beneficial microbes mostly lactic acid bacteria (*Lactobacillus*), yeast *(Saccharomyces*), actinomycetes (*Streptomyces*), photosynthetic bacteria (*Rhodopsuedomonas*) and certain fungi (*Aspergillus*) which promotes the growth and yield in different crops

Panchagavya enhances the growth and vigour of crops, inducing resistance to pests and diseases and improving the keeping quality of vegetables and fruits (Natarajan, 2002). Panchagavya spray was also reported as effective on all the crops than the recommended nutrients and growth regulators in terms of higher growth and productivity (Somasundaram, 2003).

The liquid organic manures such as panchagavya and cow urine are commonly used in organic farming to provide balanced nutrition to the crop Devakumar *et al.* (2008).

Organic farming involves scientific knowledge of ecology and modern technology with traditional farming methods. The application of organic fertilizers, cover crop and compost crop enhances soil fertility which will ultimately result in increased yield. Organic farming system cannot influence the crop yield in short term, in the long term it will improve soil fertility and establish sustainability (Mirzaei *et al.,* 2007). Organic farming benefits arable land by promoting greater densities and species diversity in weed flora, lower concentration of aphids, greater number of beneficial insects and bigger population of birds, sustain crop productivity besides maintaining the soil health (Khatik and Dikshit, 2001). Organic farming enhancing the physical, chemical and biological properties of soil (Chukwuka and Omatayo, 2009). Organic farming had a greater role in maintaining soil health and reducing the risk of soil erosion when compared to chemical farming (Reganold and Palmer 1995). The microorganisms, predominantly bacteria, yeast, actinomycetes, and certain fungi have been reported in cow dung (Swain and Ray, 2006). Organic manures are the important source of micronutrients to the plants (Vajantha 2012). Panchakavya spray increased the P, K, Na, Ca, Mg, Fe, Cu, Zn, Mn, Carbohydrates, Protein, fat and ash content in raw rice as compared to control (Yadav and Christopher Lourduraj, 2005). Panchakavya improves fertility status in soil by increasing macronutrients, micronutrients, beneficial microorganism, integrated pest and disease management and increase soil health. It improves water holding capacity of soils because it act as organic

manure which supports the growth of beneficial soil microorganisms and nutrient uptake in plants (Raghavendra *et al.,* 2014).

In the present investigation, it was found that the panchakavya treatment increases the leaf size and the number of leaves. Higher grain yield was attributed to the higher photosynthetic area thereby resulting in higher profit. These results are in conformity with the findings of Sathyamoorthi (1997) where higher leaf area index and nutrient uptake contributed for higher yield in maize by the application of bio-digester liquid, panchagavya and cow urine spray. These might be also due to presence of naturally occurring beneficial microorganisms predominantly bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi which were detected in organic liquid manures (Swaminathan 2005 and Devakumar *et al.,* 2008). Maximum grain was recorded in panchagavya sprayed plots. This was due to increase in plant height and number of leaves. These results are in corroboration with the findings of Meena and Bheemavat, (2009) that cow urine combined with application of green manures and foliar application of panchagavya resulted in better growth and development of plants for increased and maximum grain yield of maize. Cob length and cob girth were significantly higher in the plots applied with bio-digester slurry followed by plots supplied with cow urine and panchagavya liquid manures. Papen *et al.,* (2002) reported that panchagavya contains macro and micronutrients besides total reducing sugar-glucose. Chemolithotrops and autotropic nitrifiers (ammonifers and nitrifers) present in panchagavya (Rahmann and Aksoy, 2014) colonizes the leaves and increase the

ammonia uptake and thereby enhancing the total N Supply. The microorganisms present in the rhizosphere environment around the roots, influence the plant growth and crop yield. Because of these reasons crops applied with liquid manures are benefitted in terms of soil fertility, soil health.

The present study revealed that the panchakavya + animal waste increased shoot length and root length when compared to control and other treatments. Similar finding were observed in vermiwash. Panchagavya were used as foliar spray to evaluate their growth promoting effects on lablab beans. vermiwash and panchagavya treated plants showed better growth promoting effects in terms of exo-morphological characters such as shoot length, inter node length, diameter of the inter node, number of leaves and leaf surface area (Rajan and Murugesan, 2012; Nath and Singh, 2012; Swaminathan *et al*., 2007 and Prabhu *et al*., 2010).

The present study revealed the dynamics of soil fertility depends on the soil nitrogen, phosphorus and potassium, all them were found in considerable amount in panchakavya + animal waste treatment when compared to other treatments. The amount of micronutrients namely iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) also increased in the panchakavya + animal waste treated soil when compared to the other treatments. The foliar application of panchakavya + animal waste had a positive influence on the four crops grown namely ragi, green gram, paddy and roselle. Soil fertility was compared to the control and chemical was found to be four times higher in organic treatment.

In the present investigation the microbial load of the panchakavya treatments were enumerated and was found that they harbor about 1 x 10^{32} colony forming units. The microbial load was counted in both nutrient agar and MacConkey's agar, and was found that both the media favoured similar number of colony forming units. MacConkey agar is a selective and differential culture medium for bacteria designed to selectively isolate Gram-negative and enteric bacilli and differentiate them based on lactose fermentation. The crystal violet and bile salts inhibit the growth of Gram-positive organisms which allows for the selection and isolation of Gram-Negative bacteria. Enteric bacteria that have the ability to ferment lactose can be detected using the carbohydrate lactose, and the pH indicator neutral red. Therefore, the colonies obtained in the present investigation were found to be of Gram negative enteric *Bacillus* type. The total microbial count and the physicochemical properties of the soil such as pH, EC, N, P, K and OC (organic carbon), in the soils are enhanced. Presence of macro (N. P, K and Ca) and micro (Zn, Fe, Cu, Mn) nutrients present in panchagavya which colonize in the leaves increased the ammonia uptake and enhance the total N supply (Papen *et al*., 2002). The pH of panchagavya was lowered to 4.52 at 30 days of fermentation and this might be due to *Lactobacillus* bacteria in panchagavya, which produced more organic acids during fermentation (Mathivanan *et al.,* 2006). Further, the authors have reported the acetate, propionate and butyrate levels in panchagavya. *Lactobacillus* count increased in 10 days of fermentation (Shailaja *et al.*, 2014).

The beneficial effect of microorganisms from panchagavya and their establishment in the soil improved the sustainability of agriculture as the microorganisms present in the rhizospheres environment around the roots influence the plant growth and crop yield. The possible reason for higher growth characters and increased height might be due to the growth enzymes present in Panchagavya which favoured rapid cell division and multiplication (Vasumathi, 2001; Sanjutha, *et al*., 2008). Panchagavya is reported to contain bio-fertilizers like *Azospirillum*, *Azotobactor*, Phosphobacteria, *Pseudomonas* and *Lactobacillus* (Yadav and Lourduraj, 2003). The present investigation aimed to examine the efficiency of panchakavya by adding animal waste, plant leaves and neem cake. Panchakavya was more effective. It proves to be a good fertilizer, in addition it retain the soil fertility and need less water for crops when compared to chemical fertilizers. It increases the water holding capacity of the soil. Panchakavya improves physical properties of soil such as aggregation, aeration, permeability and water holding capacity (Masti *et al*,. 2003).

Panchagavya is normally advocated as foliar nutrition (Caraka-Samhita, 1981; Susruta Samhita, 1985; Chauhan, 2002b; 2004b; 2005; Fulzele *et al.*, 2001; Joshi, 2002; Garg and Chauhan, 2003a; Saxena *et al.*, 2004).

Panchakavya has been claimed to have antibacterial activities (Subramaniam, 2005, Suga, 2005), use of panchakavya as manure promote both the survival ability and nodulating efficiency in inoculated strain of *Rhizobium*. 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 (*Rhodopsuedomonas*) and certain fungi (*Aspergillus*) (Xu, 2001; Swaminathan, *et al.*, 2007). The total volatile fatty acids were higher at 30 days of fermentation. The Coliforms, *Streptococci* and *Staphylococci* counts were not in detectable range. Yadav and Lourduraj, (2005) reported *Azospirillum, Azotobactor, Phosphobacteria* and *Pseudomonas* from Panchagavya. Panchakavya also contains phosphate solubilizing microorganisms. Microorganisms in panchakavya also secrete plant growth hormones that increase growth rates and improved yields of host plants (Brown *et al.*, 1976).

The present study revealed the efficacy of panchakavya against bacterial culture namely plant pathogen *Xanthomonas citrus*. Similar finding were observed the panchagavya had the highest population of total bacteria, actinomycetes, phosphate solubilizers, fluorescent pseudomonads and nitrifiers. panchagavya has been claimed to have antibacterial activities (Subramaniam, 2005; Sugha, 2005),

The present investigation was hypothesized to examine the efficiency of panchakavya against the fungi *Pyricularia oryzae* using methanol extracts in panchakavya + plants. Similar finding were observed. In addition, dehydrogenase activity and microbial biomass were also found to be higher in panchagavya (Amalraj *et al.*, 2013). Jandaik and Sharma (2016) have recently reported the antifungal activity of panchagavya against three plant pathogens

Rhizoctonia solani, *Fusarium oxysporium* and *Sclerotium rolfsii*. In their study, panchagavya exhibited antifungal activity against all the three pathogens at three different concentrations (Jandaik and Sharma, 2016).

Prashith Kekuda (2010) reported antifungal activity of cow urine. It was concluded that cow urine and cow urine distillate increased the activity of antibiotics against tested bacterial pathogens. Cow urine distillate was more effective bio-enhancer than cow urine in combination with antibiotics. Cow Urine Concentrate is the residue which is left out when the cow urine is subjected to complete distillation. A marked antibacterial, antifungal and anthelmintic activity of Cow Urine Concentrate was observed in this study. The inhibitory activity of Cow Urine Concentrate could be mainly due to the presence of active constituents in it. The Cow Urine Concentrate could be used in the treatment of diseases caused by pathogenic bacteria, opportunistic fungi and parasitic helminthes. Further studies on isolation of active constituents and in vivo experiments are to be carried out to justify the potential of Cow Urine Concentrate as antimicrobial and anthelmintic agent.

The present study revealed the lipase activity of panchakavya that showed the highest lipase assay were in panchakavya + animal waste when compared to control as well as other different samples of panchakavya combinations. Similar findings were observed by Saneesh kumar (2013). Cow's urine was highly effective and stable in inhibiting and controlling the growth of fungi and bacteria. Ancient ayurvedic emphasized the antimicrobial activity of cow's urine and this research helped ascertain the fact. Also cow's

urine was concluded to be one of the best natural sources of lipase enzyme. The excellent lipase activity within the urine sample makes it a highly efficient therapeutic in curing many diseases.

The dual culture of panchakavya and *Pyricularia orzyae* and the spore germination frequency of *P. oryzae* in panchakavya amended plates clearly show that the fungal pathogens are inhibited. The net result is that the fungal attack on panchakavya treated plants is reduced.

Panchakavya was analyzed for biochemical compounds and many compounds were found to be present in various extracts. Certain biochemicals can be newly synthesized due to the microbial flora present in the panchakavya sample. Similar finding were observed by Sritharan (2010) where separation of bio-chemicals and their quantification in TLC was carried out and analyzed in High Performance Thin Layer Chromatography (HPTLC). The HPTLC profiles of different fractions of panchakavya indicate the presence of phenolic and flavonoid type compounds (Pankaj Naria *et al*., 2012)

The HPTLC analysis data revealed that totally 42 chemicals, having different R_f values were recorded, in both Panchagavya treated and control. Withania, Mukia and Prosophis might be due to the influence of various phytochemicals, which had stimulant activity on various physiological parameters and also acted as antioxidants of certain phytochemicals. The isolation of phytochemical compounds through HPTLC brings out the fact that certain compounds have been synthesized in higher amounts due to the application of panchakavya when compared to the control. Panchakavya

treated plants synthesized more number of secondary metabolite compounds which might have favoured the physiological processes and resulted better growth performance coupled with yield and quality parameters of black nightshade. In-depth analysis indicated that certain phytochemicals can be newly synthesized due to panchakavya treated plants. This implies that these phytochemicals might influence the yield and quality characters of black nightshade. Purification and characterization of these phytochemical may lead to further understanding of the quality of these phytochemicals and their possible usage in other agricultural crops.

Antimicrobial agents are essentially important in reducing the global burden of infectious diseases. The Ayurvedic medicines of animal origin are mainly prepared from panchakavya which boost up the body immune system and makes the body refractory to various diseases (Chauhan, Lokesh Singhal 2006). The bacterial infections are usually treated with antibiotics. The antibiotic sensitivity of different strains of *Escherichia coli* vary widely. (Muthukumaravel *et al*, 2008). Microorganism like bacteria and fungi are mainly responsible for the increased infections in human beings and animals. Cow urine having curative properties in skin diseases, especially leprosy is referred to in Caraka Samhita. Cow is a mobile medical dispensary and cow urine is a panacea of all diseases. The panchakavya is capable of treating many curable as well as incurable diseases and has been used extensively in ayurvedic preparations since time immemorial as cited in ancient holy texts

like Charaka Samhita, Sushruta Samhita, Vridhabhagabhatt, Atharva veda, Bhavaprakash, Rajnighuntu, Amritasagar (Dhama *et al.*, 2005). The present study highly proved that panchakavya enhances the yield two folds. Panchakavya application is found to be more profitable than recommended fertilizers and it retains soil fertility. The plant growth substances in panchakavya help to bring rapid changes in phenotypes of plants and also improve the growth and productivity (Tharmaraj, 2011).

Sustainable agricultural practices encompass several agricultural practices that are being practiced by the farming community in different parts of the country. Ecological agriculture revolves around three important factors namely soil, water and the seed. In nature, organic relationships are a pervasive phenomenon and everything inter-connected. The integral relationship seen between soil, water, flora, soil microbes is obvious. It is the totality of these relationships that becomes the bedrock or organic and sustainable farming. Much of the understanding of this relationship is reflected in this sustainable agricultural practice. Maintaining soil fertility and productivity on sustainable basis is of primary importance for continuous agriculture production; knowledge that has been in existence for over 2000 years has been undermined. Indigenous agricultural knowledge is a vital part of them, process of making agriculture sustainable, is an attempt to complete all the traditional practices for crop improvement, increment in growth and yield of a crop, pest and disease management, nutritional deficiency, soil and moisture conservation, animal in agriculture etc.

An agricultural strategy based on indigenous knowledge and traditional cropping systems can bring moderate to high levels of productivity using local resources alone. Given favourable social and ecological conditions, such systems are sustainable at a low cost for a long period. Understandably, Indian agro products are known to be more organic than that of most developed countries, keeping in view the traditional agronomic practices followed by small farmers. Organically grown produce has got its own export values for which a systemic research and development programme in respect of sustaining agricultural system through pure organic agriculture needs initiation. Now the need has come to reexamine and then gradually re-introduce the effective traditional methods of plant nutrition using organic sources. Hence an attempt was made to assess the effect of organics application on the yield and economics in ragi, green gram, rice and roselle based cropping system.