REVIEW OF LITERATURE

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AIM AND SCOPE OF STUDY

REVIEW OF LITERATURE

Vriksh Ayurvedha is an ancient system, which synchronizes all agricultural operations with natural forces emanating out of the panchabhootas, viz, earth, water, air, fire and space. When human beings, animals and plants were in perfect harmony, everything was wholesome and no remedial, correctional and improvement measure was required, as there is no ailment. As a consequence of the domination and exploitation of flora and fauna by humans, and deviation from a natural life-style, problems propped up due to forced imbalances in natural elements, and well-beings.

Agriculture was no exception as health care for soil, plants, animals and microorganisms as well as humans has deteriorated over time, chemical agriculture has worsened the scenario and health hazards have increased exponentially.

Masanobu Fukuoka, (1998) author of the one straw Revolution was one of the first to voice these concerns across the world and sensitize the minds of thought full scholars. Rachel Carson, (1962) the author of silent spring, created a powerful wave against the invasion of chemicals into agriculture, the environment and the human body. The chemical agriculture continued over the decades to poison the land, water and air as a result, many crop laboratories of the world, reputed international figure and non-government organizations extended their support to organic farming. A green movement arose in the west, which championed the cause of organic agriculture during the later period.

Theories and concepts of organic agriculture were developed and popularized under different names viz, organic agriculture, green culture, natural farming, and do-nothing farming etc. The enlightened public started demanding toxin-free food products. The market demand for organic produce gave further momentum to the organic movement, and eventually sporadic attempts have been made to detoxify the land, dispense with chemical fertilizers, pesticides, fungicides and herbicides, and grow crops organically and organic agriculture picked up momentum.

In Sanskrit, panchakavya means the blend of five products obtained from cow (all these five products are individually called 'Gavya' and collectively termed as 'Panchakavya). When suitably mixed and used, this had positive influence on living organisms. Panchakavya had got reverence in the scripts of Vedas (divine scripts of Indian wisdom), and Vrkshayurveda (vrksha means plant and ayurveda means health system). The texts on Vrkshayurveda are systematization of the practices that the farmers followed at field level, placed in a theoretical framework and it defined certain plant growth stimulants; among them panchakavya was an important one that enhanced the biological efficiency of crop plants and the quality of fruits and vegetables (Natarajan 2002).

PROPERTIES OF PANCHAKAVYA

Nene (1999) reported that cow dung had been used by Kautilya, Varahamihira, Surapala and Someshwara Deva in ancient history. It contained undigested fibre, epithelial cells, pigments and salts, rich in nitrogen, phosphorous, potassium, sulphur, micro nutrients, and intestinal bacteria and mucous. Cow dung was also rich in bacteria, fungi and other microbial organisms. Singh (1996) recorded that cow dung had water 82% and solid matter 18 % including (minerals 0.1%, ash 2.4 %, organic manure 14.6 %, Ca and Mg 0.4 %, SO_2 0.05 %, silica 1.5 %, N 0.5 %, P 0.2 %, K 0.5%.

Reddy (1998) reported that cows urine was rich in urea and acted both as a nutrient as well as hormone. Cow's urine had 91 % water and 9 % solid matter, minerals 1.4 %, ash 2.0 %, Ca and Mg 0.15 %, $SO_3$0.15 %, silica0.01%, N 1.0 %, P traces and K 1.35 %. Urine also contain uric acid and hipuric acid in large quantities along with other mineral matter like NaCl, sulphates of Ca and Mg, potassium hipurate (Singh,1996).

Cow's milk had been used by farmers in ancient times and reported to be an excellent sticker and spreader (casein), a good medium for saprophytic bacteria and a virus inhibitor (Nene, 1999). Milk contain protein, fat, carbohydrates, amino acids, calcium, lactic acid also *Lactobacillus* bacteria. Many microorganisms could ferment either five or six carbon sugars, but the *Lactobacillus* bacteria could ferment both (Linda McGraw, 1999).

Nene (1999) reported that cow's ghee had been used in ancient and medieval times for managing seedling health. The ghee contained vitamin A,

B, calcium, fat, glycosides, which protected wounds from infections. Cow's curd is rich in microbes (*Lactobacillus*) that are responsible for fermentation (Chandra, 1996).

Foliar spray of coconut water as growth hormone increased the biomass and yield 200 percent over control as reported by Mamaril and Lopez (1997). With application of coconut in any form increased the chlorophyll content and photosynthetic activity for longer period (Kalarani, 1991).

The beneficial role of panchagavya on several crop plants was confirmed by several workers viz., Beaulah (2001), Beaulah *et al*. (2002), Pathak and Ram (2002), Boomiraj (2003), Somasundaram (2003), Sridhar (2003), Yadav and Lourduraj (2006).

MICROBIOLOGICAL ASPECTS OF PANCHAKAVYA

Solaiappan (2002) found that in panchakavya proven bio-fertilizers such as *Azospirillum, Azotobacter, Phosphobacteria* and *Pseudomonas* were found. Besides *Lactobacillus*, ammonia and nitrite oxidizers are found to colonize the leaves and increased the ammonia uptake and total N supply of spruce trees (Papen *et al*., 2002).

INFLUENCE OF PANCHAKAVYA ON GROWTH, YIELD AND QUALITY OF CROPS

In jasmine, spraying twice of panchakavya at 3 % one before the flower initiation and another during bud elating phase ensure continuous flowering. Panchakavya sprayed on chilies produced dark green

leaves and new growth within 10 days (Subhashini *et al.*, 2001). In annual M*oringa*, panchakavya spraying doubled the fruit yield besides giving resistance to pest and diseases (Vivekanandan, 1999) and 50% increase in flowering (Beaulah 2001). Ramya (2017) reported that panchakavya spray increases fruiting in *Solanum melongena* and *Abelmoschus esculentus*. Panchakavya spray at 3% increases the plant growth and yield in *Abelmoschus esculentus* and *Vigna mungo* (Rajasekaran and Balakrishnan, 2002; Brito and Girija, 2006; Somasundaram *et al*., 2007; Kumaravelu and Kadamban, 2009), *Oryza sativa* (Tharmaraj, 2011), *Coleus forskohili* (Kanimozhi, 2003), black gram (Swaminathan *et al*., 2007), groundnut (Ravikumar, 2012), *Moringa oleifera* (Beaulah, 2002), aswagandha (Mohanalakshmi and Vadivel, 2008).

EFFECT OF PANCHAKAVYA ON PEST AND DISEASES

Panchakavya controlled the wilt of banana (Reddy and Padmodaya, 1995), wilt of tomato (Mishra, 2002) and it was found to be superior to carbendazim in reducing the plant disease index and increasing the vigor of the plant and fruit yield of tomato (Reddy and Padmodaya, 1996). Panchakavya was found to activate soil and to protect plants from diseases (Shenoy *et al.,* 2000). Panchakavya spray with fumigation in the field recorded the least population of cutworms, which resulted in higher yield in potato (Selvaraj, 2003). Boomiraj *et al* (2004) reported that panchakavya was effective against leafhopper (*Ambrasca biguttula*) and white fly (B*emisiatobaci*). Panchakavya proved as best in managing *Spodoptera litura* larvae followed by panchagavya + *Vitex nigundo* and calotropis in groundnut

and soybean; (Bharati 2005). Neelakanth (2006) noted that panchagavya proved best over spinosad in controlling *Plutella xylostella* in cabbage and shoot fly in sorghum (Mudigora *et al*., 2009).

IMPROVING THE PANCHAKAVYA

Since panchakavya was innovated in the year 1998, it has seen many modifications, many refinements and found many uses. In the last 10 years it has gathered many valuable and priceless experiences by many farmer scientists, vets and physicians, across the country. Now it became an important, irreplaceable and a standard input in organic agriculture and revolutionized the organic farming to attain the peaks in quality and production. Rural Community Action Centre, Kodumudi, Tamil Nadu, experimented with panchakavya by enriching it with fifteen more organic materials and finally recommended the addition of tender coconut water, sugarcane juice and banana fruit to add the potency (Natarajan, 2002). Biomass was also found to be higher in Panchakavya (Amalraj *et al*., 2013).

SUGAR BASE

Sugar accelerates the fermentation process; initially honey was added along with panchakavya. Considering the cost of honey, jaggery was added instead. However, jaggery contains chemical ingredients; sugarcane juice was substituted to accelerate the fermentation process. Bananas were also added to act as a substrate for microorganisms.

BAD ODOUR OF PANCHAKAVYA

The panchakavya was emitting a bad smell due to the fermentation process. Experiments with various quantities of ingredients as an additional ingredient contained the bad odour to a greater extent and also enhanced the fermentation process (Natarajan, 2012).

TENDER - COCONUT WATER

The tender-coconut water not only accelerated the fermentation process but also activated the growth of meristem at a faster rate, since it contains cytokinin. Thus the latest form of panchakavya suited to various agriculture and horticultural crops, has been standardized.

PHYSICOCHEMICALANDBIOLOGICALPROPERTIESOF PANCHAKAVYA

Panchakavya contains macro and micro nutrients necessary for the plants, growth promoting factors like IAA, GA, and beneficial microorganisms *Acetobacter*, *Phosphobacteria* and *Pseudomonas* in abundant numbers, it also contains some useful fungi and actinomycetes.

In India, drinking of cow urine has been practiced for thousands of years. Panchakavya is a term used in ayurvedha to describe five important substances obtained from cow namely urine, dung, milk, ghee and curd. A number of formulations mentioned in ayurvedha described the use of panchakavya components either alone or in combination with drugs of herbal or animal origin (Shah, 1997).

The organic farming could serve as a holistic approach towards achieving sustainable agriculture as it is nature based, environment friendly and ensures the conservation of resources for the future. Organic farming is quite distinct in the sense that it relies on closed nutrient cycles with less dependence on off farm inputs.

The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable food production. The cost of inorganic fertilizers is increasing enormously to an extent that they are out of reach for small and marginal farmers. The panchakavya, jeevamruth and Beejamruth are eco-friendly organic preparations made from cow products. These are responsible for higher growth, yield and quality of crops. They contain growth promoting factor like IAA, GA, and beneficial microorganisms (Natarajan, 2007; Sreenivasa *et al*., 2010).

Chemical agriculture has made an adverse impact on the health-care of not only soil but also the beneficial soil microbial communities and the plants. This eventually has led to a high demand of 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, pesticides, fungicides and herbicides.

The farmyard manure of soya bean and bio-fertilizers increased the total number of root nodules per plant. Vermicompost, which are stabilized organic materials produced by interaction between earthworms and microorganisms in a non-thermophillic process enhances plant growth and yields in greenhouse crops (Dubey, 1997; Edwards and Arancon, 2004; Edwards *et al*., 2004).

The combined application of cow dung manure + vermicompost + poultry manure in soybean and chickpea cropping sequence resulted in the improvement of soil organic carbon content, available soil N, P and K compared to either recommended dose of fertilizers or control (Ramesh *et al*., 2010; Yadav *et al*., 2009).

Vermicompost increases crop production, yield parameters of crops like wheat, paddy and sugarcane (Ismail, 2005; Ansari, 2008). Vermicompost are peat-like materials with high porosity, aeration, drainage, water-holding capacities and low C:N ratios produced from organic wastes stabilized by interactions between earthworms and microorganisms (Edwards 1998).

Vermicompost is rich in both macro nutrients (0.56% N, 0.48% P_2O_5 and 0.36% K_2O) as well as micronutrients besides containing plant growth promoting substances, humus forming microbes and nitrogen fixers (Shinde *et al.*, 1992; Giraddi, 1993; Halemani *et al.*, 2004). Vermiwash spray has significantly enhanced the growth (plant height and number of leaves) and yield (number of flowers and fruits per plant) of *Solanum melongena* (Sundararasu and Jeyasankar, 2014).

Poultry manure application was observed to improve the physical properties of soil (Ravikumar and Krishnamoorthy, 1975) such as bulk density, water holding capacity and percent water stable aggregation (Weil and Kroantje, 1979). In fresh poultry excreta, uric acid or urate was the most abundant nitrogen compound (40-70 % of total N) while, urea and ammonia was present in small quantities (Krogdahl and Dahlsgard, 1981). Poultry

was present in small quantities (Krogdahl and Dahlsgard, 1981). Poultry manure is used as a source of N, P and K but litter also contains Ca, Mg, S and some micronutrients (Mullins *et al*., 2002).

Poultry manure resulted in significantly higher phosphorous concentration in leaf sample of banana five months after planting. Maximum grain yield of rice was recorded with the application of poultry manure (Iyengar *et al*., 1984; Prasad *et al*., 1984).

Traditional disposal methods for solid hatchery waste include land fill, composting, and rendering. Hatchery waste is a high protein waste with 43-71% moisture. Dried hatchery waste contains 33.1% crude protein (CP), 29% ether extract, 12.1% crude fibre, 21.5% ash and 28.8 MJ/kg of gross energy. Eggs shells can be composed with other organic materials to increase the material content of the compost. Crushed egg shell also used (PhilGlatz *et al*., 2011).

Pongamia pinnata trees are normally planted along the highways and canals to stop soil erosion. It is generally 8 meters and a trunk diameter of more than 50 cm. The trunk is generally short with thick branches spreading into a dense hemispherical crown of dark green leaves. *Pongamia pinnata* is a preferred species for controlling soil erosion and binding sand dunes because of its dense lateral roots. Root, bark, leaves, flower and seeds of this plant also have medicinal properties and traditionally used as medicinal plant. All parts of the plant have been used as crude drug for the treatment of tumors, piles, skin diseases, wounds and ulcers (Tanaka *et al*., 1992).

Tripathi *et al*. (2012) observed that in and around the crop fields where *Pongamia pinnata* is planted there was no infestation of various types of insect-pests, grass-hoppers, caterpillars, leafhoppers etc.

Vitex negundo Linn (*Verbenaceae*) commonly known as Nirkundi or Nallanocci. It is an aromatic large shrub or small tree about 3m in height with quadrangular branches and also almost found throughout India. *Vitex negunda* leaves showed significant antifungal activity and insect repellent activity. The ointment made from the juice is applied as hair-tonic. It commonly bears tri-or penta-foliate leaves on quadrangular branches, which give rise to bluish - purple coloured flowers in branched tomentose cymes.

Adhatoda vasica (Acanthaceae) is an evergreen shrub of 1-3 feet in height. Its trade name is Vasaka based on Sanskrit (Kumar *et al*.,2010). The leaves, flowers, fruit and roots are extensively used for treating cold cough, whooping cough, chronic bronchitis and asthma, as sedative, expectorant and antispasmodic (Pandita, 1983).

Adhatoda vasica native to India is distributed all over the plains of India. *Adhatoda vasica* is highly valuable in cleaning phlegm and lung problems, was infested with seasonal pests. Infested leaves showed high ash value out of which sulphated ash content was almost 80% and more. This possibly interfered with the curative value of the green drug leading to allergy (Emimal, 2010). *Adhatoda vasica* is an insecticidal plant (Rathi *et al*., 2008). Leaf extract has anti feeding activity against *Spodoptera littoralis* (Sadek, 2003) and *Brevicorynebrassicae* (Haifa and Ali, 2016).

Citrus limon (*Rutaceae)* originated in India, grown commercially worldwide in tropical, semi-tropical region for the fruit, which is used fresh and in beverages and cooking, and is also used as a preservative due to its anti-oxidant properties.

The lemon tree grows to 6m (20ft) tall. Lemons have antioxidant properties, so lemon juice is often added to fresh fruit to prevent oxidation and browning. Lemon oil, obtained from the peel, is used as a wood cleaner and polish, and as a non-toxic pesticide. Traditional medicinal uses for the fruit, peels, oil obtained from seeds includes treating astringent and diuretic. Many Indian medicinal plants have been used for the prevention and treatment of gout and related inflammatory disorders (Muthiah, 2012).

The antifungal activity of panchakavya was observed against three plant pathogens *Rhizoctoniasolani*, *Fusarium oxysporium* and *Sclerotiumrolfsii* (Jandaik and Sharma 2016). Studies have shown, increased yields, where the farmer has used organic practices (Singh *et al*., 2001; Ramesh *et al*., 2005) in crops like chili (Subhashini, *et al.* 2001), moringa (Beaulah *et al.,* 2002), green gram (Somasundaram *et al.* 2003) and french bean (Selvaraj, 2003). It can be concluded that Panchakavya is an organic growth-promoter for small and marginal vegetable growers (Boomathi, 2006).

In the present study a preliminary attempt has been made to find out the effect of panchakavya as an aerial spray to enhance the growth and yield of crops. The efficiency of panchakavya would be tried to increase by adding adjuvants. Plants with insecticidal properties have been used since ancient

times as pesticide and fungicide and dried leaves in storage to ward away the insects from the grains. Therefore, in the present study the common plants with insecticidal properties like *Vitex negunda, Pongamia pinnata, Adhatoda vasica,* and *Citrus limon* would be used to render the panchakavya with more pesticidal and fungicidal properties.

Animal waste like poultry waste, fish waste and egg shells have macro and micronutrient content which could be added to the panchakavya. This will give the panchakavya an additional fortification with micronutrients that could enhance the crop growth and yield. Neem has proven antiviral, antibacterial and antifungal properties, neem in any form acts as a repellent for insect pests. Therefore, in the present study neem cake would be added as one of the adjuvant so that the panchakavya will have more pesticidal and fungicidal properties.

In the present investigation the four types of panchakavya namely panchakavya, panchakavya+plants, panchakavya + animal waste and panchakavya + neem cake would be compared with an organic fertilizer namely vermicompost and an inorganic fertilizers (depends up on the crop) and control.

In the present study four crops namely ragi, rice, green gram and roselle will be cultivated. Two cereal crops were chosen which forms the stable food of the Indian subcontinent. Of the two cereals, ragi (*Elusine coracana;* Finger millet) belongs to the millet which could withstand arid dry climate and is a sturdy crop with assured yield even with least irrigation and

fertilization. Whereas rice (*Oryza sativa*) is an important crop grown in well irrigated fertile regions mostly in alluvial soil and needs care in the form of irrigation, manuring and plant protection.

Green gram (*Vigna radiata*) belongs to the pulse variety with rich protein content and mostly as an intercrop in rice cultivated regions. They are cultivated in the rice fields to enhance the soil fertility since they possess nitrogen fixing symbiotic bacteria in their root nodules. Roselle (*Hibiscus sabdariffa)* is green leafy vegetable cultivated in the tropical and subtropical climates. They are cultivated in almost all parts of India for their edible leaves and in the preparation of jams and jellies. The fibre from these plants are a substitute for jute.

The treatments would be used to grow the crops and compared for their growth, yield and pathological symptoms on all the four crops.

The soil would be analyzed for their fertility by assessing the physicochemical properties and macro and micronutrient content. The growth promoting efficiency of the treatments would be studied.

The biochemical content of the panchakavya preparations would be analyzed. The microbial load of panchakavya and their antimicrobial activity would be studied against plant pathogens.

AIM OF THE STUDY

- To enhance the efficiency of panchakavya by bringing out new formulations. Adjuvants like plants, animal waste, neem cake would be tried.
- To study the effect of panchakavya and the adjuvants on the growth and yield of four crops, namely ragi, green gram, paddy and roselle (green leafy vegetable).
- To study the soil fertility of the field before and after the cultivation of the crops.
- To study the pathological symptoms observed in the four crops.
- To study the growth promoting efficacy of Panchakavya and their adjuvants.
- To study the chemical constituents of panchakavya by TLC, HPTLC and GC-MS analysis.
- To study the Microbial load of Panchakavya.
- To analyze the antimicrobial activity of panchakavya against plant pathogenic bacteria and fungi.