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Jeevamrut and Panchagavya's Consequences on Growth, Quality and Productivity of Organically Grown Crops: A Review

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ABSTRACT

Organic farming and organically produced food products are gaining popularity very rapidly in India and world. To trounce the reliance on chemical fertilizers for crop production liquid organic bio-fertilizers and manures are very excellent and cheap sources on the earth because of easy availability and good source of nutrients. Among these Jeevamrut, Beejamrut and panchagavya are the one of the best, which contains almost essential plant nutrients (nitrogen, phosphorus, potassium, zinc, copper, manganese *etc.*), enzymes (acid phosphatise, alkaline phosphatise, dehydrogenase *etc.*) and microbes (bacteria, fungi, actinomycetes, free living nitrogen fixers and phosphorus solubilising organisms), which directly enhances plant metabolism resulting better growth and development. Jeevamrut is well thought-out to be a brilliant source of natural carbon, nitrogen, phosphorous, potassium and lot of other micro nutrients required for the crops and popularly used as means of organic farming. Panchagavya was used in conventional Hindu rituals which is prepared by mixing five ingredients *viz.,* cow dung, urine, milk, curd and ghee. Jeevamrut and Panchagavya have potential to play the role of promoting growth and provide immunity in plant system. In this manuscript various effects of applications of Jeevamrut and Panchagavya on crops grown in organic farming and their consequences will be discussed.

Key words: Consequences, Growth, Jeevamrut, Organic crops, Panchagavya, Productivity.

Preference of consumers for organic crops as well as food products is increasing day by day. Farmers need improved practices for cultivation of crops with organic standards as national programme on organic production. At national and state level, package of practices for organic farming of wheat has been developed (Ravishanker *et al*., 2017 and Sharma *et al.,* 2017). It has been reported that yield of organic wheat decreases by 5 to 8 per cent after 6 years of organic cycle. However, organic wheat fetches 20-25 per cent high premium price in the market. Use of organic inputs for high productivity and economical cultivation of wheat is very important. There are various options for the use of organic inputs in organic cultivation of wheat and use of liquid organic input preparations or formulations is one of them (Sharma *et al*., 2015). Liquid organic formulations have largely remained in the background of mainstream scientific literature and what little knowledge exists about them is mainly confined to biodynamic farming literature (Divers, 1999). In India, the traditional liquid fertilizer called panchagavya, has been shown to have a modest NPK content of 0.03-0.02-0.04 but a high iron content of 0.84 per cent. Other Indian liquid manures such as jeevamrut and beejamrut are reportedly used not as sources of nutrients but as plant growth enhancers (Palekar, 2006 and Vasanthkumar, 2006). Liquid formulations used in organic agriculture like panchagavya, beejamrut and jeevamrut are the fermented products which are used as plant growth enhancing substances prepared with the materials available with farmers. They are rich sources of beneficial micro-flora who stimulate the plant growth and help in getting better vegetative growth and also good quality yield. Formulations prepared from agricultural by- products *viz.*, bran of grains, oil cakes, farmyard manure *etc.*, are excellent growth carriers and storage media (Devakumar *et al*., 2011). During the last few years, there has been an increasing interest in the use of panchagavya, beejamrut, jeevamrut and other liquid organic manures/bio-fertilizers in organic agriculture. Devakumar *et al*. (2008) and Sreenivasa *et al*. (2010) have reported many beneficial micro-organisms *viz.*, nitrogen fixers, phosphorus solubilizers, actinomycetes and fungi are present in jeevamrut and beejamrut.

The advantage of liquid organic manure is that they disperse in water and rapidly taken up by plants as compared to solid organic fertilizers. Plant can absorb nutrients about 20 times faster through the leaves than applied through the soil, helping in overcoming temporary, acute nutrient shortages in the crops. The uniqueness of organics is that they provide growth promoting hormones and immunity boosters for plants (Xu *et al.*, 2000; Sreenivasa *et al.*, 2011).

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Jeevamrut, a newly introduced liquid manure prepared from cow dung, cow urine, pulses flour, jaggary and soil collected from virgin land or below the canopy of banyan tree, helps to enhance microbial population, soil fertility and productivity. Few research studies have been done on this aspect and indicated that use of jeevamrut promote growth and productivity of crops (Boraiah, 2013). An organized research work on development of technologies for production of organic wheat in India was started after launch of National Programme on Organic Production (Ravishanker *et al.,* 2017). Recently, the use of a number of organic liquid formulations *viz*., Jeevamrut, Beejamrut, Panchagavya, Compost tea and Amrit pani in the organic farming have been recognized world over. Since, the research work done on the use of jeevamrut in wheat and other field crops is very meagre and therefore, crops including horticultural crops under organic production or organic versus conventional production system in India and abroad has been included to elucidate the related points.

Concept of organic farming

In 1980, the United States Department of Agriculture defined the concept of organic agriculture as follows: "A production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent feasible, organic agriculture systems rely upon crop rotations, crop residue, animal manure, legumes, green manure, off-farm organic wastes, mineral bearing rocks and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients and to control insects, weeds and other pests". It considers that soil is a living system which must be "fed" in a way that does not restrict the activities of beneficial organisms necessary for recycling nutrients and producing humus is central to this concept."

According to the Codex Alimentarius Commission, "organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system."

Unsystematic use of chemical fertilizers, pesticides and growth regulators during the green revolution period resulted in several harmful effects on soil, water and air causing of pollution. This reduced the productivity of the soil by deteriorating soil health in terms of soil fertility and biological activity. The excess use of pesticides has led to the entry of harmful compounds into food chain, death of natural enemies and development of resistance to pesticides. Hence, enhancement and maintenance of system productivity and resource quality is essential for sustainable agriculture. Organic farming relies mainly on organic sources to maintain soil health, supply plant nutrients and minimize insects, weeds and pests by reducing the resistance of weeds and pests from reduced or no use of agro-chemicals.

Organic farming in the world

The regions with the largest areas of organically managed agricultural land are Oceania (27.3 million hectares or 39 per cent of the global organic farm land), Europe (13.5 million hectares or 19.5 per cent of the global organic farmland) and Latin America (7.1 million hectares or 1.028 per cent). The countries with the most organic agricultural land are Australia (22.7 million hectares), Argentina (3.1 million hectares) and the United States (2.0 million hectares). On a global level, the organic agricultural land area increased by 6.5 million hectares compared with 2014. The highest shares of organic agricultural land are in Liechtenstein (30.2 per cent) and Austria (21.3 per cent). There were almost 2.4 million producers and the countries with the highest numbers of producers are India, Ethiopia and Mexico (FiBL and IFOAM Year Book, 2017).

Organic farming in India

As on 31st March 2018, total area under organic certification process (registered under National Programme for Organic Production) is 3.56 million ha (2017-18). This includes 1.78 million ha (50%) cultivatable area and another 1.78 million ha (50%) for wild harvest collection. Among all the states, Madhya Pradesh has covered largest area under organic certification followed by Rajasthan, Maharashtra and Uttar Pradesh. During 2016, Sikkim has achieved a remarkable distinction of converting its entire land (more than 76,000 ha) under organic certification. India produced around 1.70 million tonnes (2017-18) of certified organic products which includes all varieties of food products namely oil seeds, sugarcane, cereals and millets, cotton, pulses, medicinal plants, tea, fruits, spices, dry fruits, vegetables and coffee *etc.* The production is not limited to the sector but also produces organic cotton fibre, functional food products. Among different states Madhya Pradesh is the largest producer followed by Maharashtra, Karnataka, Uttar Pradesh and Rajasthan. In terms of commodities oil seeds are the single largest category followed by sugar crops, cereals and millets, fibre crops, pulses, medicinal, herbal and aromatic plants and spices and condiments (APEDA, 2018).

Effects of Jeevamrut and Panchgavya on organically cultivated crops

The bio-chemical composition of Jeevamrut is shown in Table 1, which contains good amount of macro and micro nutrients. The method of preparation of Jeevamrut is presented in the Fig 1 and effect of Jeevamrut and Panchgavya on crop production are discussed in this section of the manuscript. The Production practices for organically cultivated crops differ from conventional crops production. For organic farming of wheat, besides avoidance of fertilizers and pesticides, all practices of crop cultivation and land management are done as per standard of National Programme on Organic Production. Sharma *et al.* (2017) reported that for organic production of wheat, package of practices like basal application of neem cake @ 200 kg ha^{-1}, seed treatment with *Azotobactor* and PSB culture @ 500 g each, seed treatment with *Trichoderma* @ 8 g kg^{-1} seed and 13 tones FYM are recommended and recorded an average yield of 3500-3800 kg ha^{-1}. Results of ICAR- Network Project on Organic Farming revealed that with standard package of practices of organic farming at Ludhiana, variety BWL-0134 recorded significantly higher grain 4278 kg ha^{-1} (Annual Report, 2015-16).

Table 1: Bio-chemical composition of jeevamrut (Bhadu, 2019).

Parameters	Values
pH	4.04
EC (dS m^{-1})	1.70
Total Nitrogen (%)	1.90
Total Phosphorus (%)	0.201
Total Potassium (%)	0.291
Total Zinc (ppm)	4.25
Total Iron (ppm)	285
Total Manganese (ppm)	1.84
Bacterial count (cfu ml^{-1})	6.33×10^{8}
Fungal count (cfu ml^{-1})	5.1×10^{4}
Actinomycetes (cfu ml^{-1})	3×10^{5}
Acid Phosphatase (µg ml^{-1})	0.931
Alkaline Phosphatase (µg ml^{-1})	1.068
Dehydrogenase (µg ml^{-1})	2.771

Effect on growth characters

The findings of various experts revealed that Jeevamrut and Panchgavya showed positive effect on growth characters of organically cultivated crop. Palekar (2006), observed higher growth, yield and quality of different crops by use of beejamrut, jeevamrut and panchgavya. Results revealed that application of RDF + FYM, organic manures in combination with beejamrut + jeevamrut + panchgavya and compost + vermicompost + green leaf manure alone recorded higher seed yield of soybean, wheat and soybean equivalent yield (Shwetha, 2008). At Karnataka, Upperi *et al.* (2008) reported that application of jeevamrut with the recommended dose of fertilizer for the production and management of leaf spot diseases in pomegranate and groundnut crops were conducted in farmer's field. Application of jeevamrut increase mean yield of both the crops as compared to control. The application of FYM @ 7.5 t ha^{-1} + jeevamrut gave higher seed yield of sunflower as compared to its individual

Materials required for preparation of jeevamrut

1.Water	:	200 litres
2.Cow dung	:	10 kg
3.Cow urine	:	10 litres
4.Jaggery	:	2 kg
5.Pulse flour	:	2 kg
6.Soil under the canopyof banyan tree	:	One handful (About 100 g)

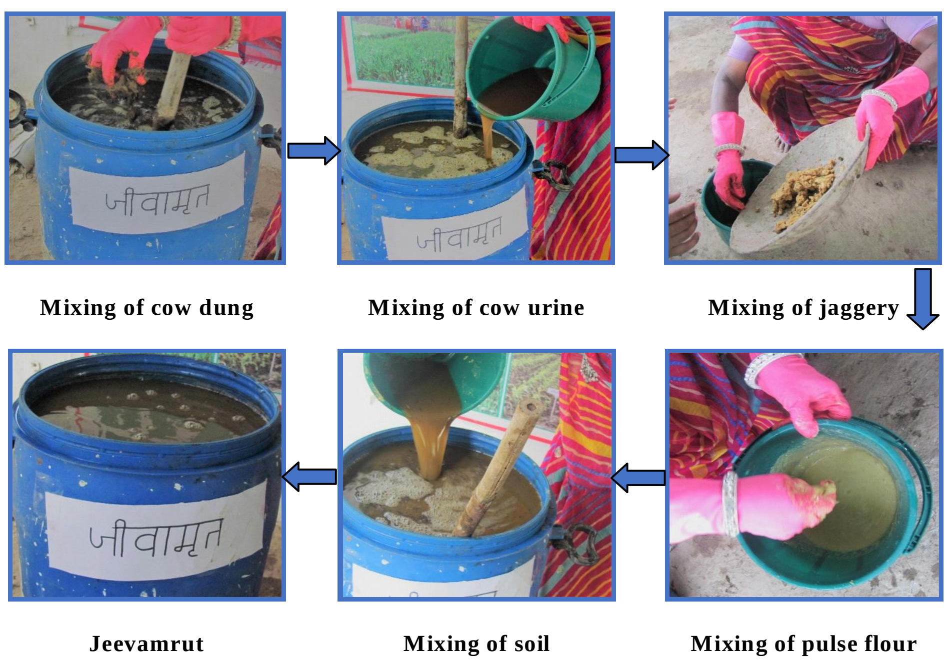

Fig 1: Procedure of jeevamrut preparation (Bhadu, 2019).

application (Manjunatha *et al.,* 2009). This is closely in conformity with the findings of Sreenivasa *et al*. (2010) who reported that the plant height, number of fruits and fruit yield of chilli were significantly higher in plots with RDF + beejamrut + jeevamrut + panchagavya. The better nutrient availability and nutrient uptake increased the growth and yield of crop. Deshmukh *et al.* (2010) conducted an experiment at Nagpur (Maharashtra) and results revealed that the application of jeevamrut @ 200 l ha^{-1} recorded statistical equivalent value of growth and yield parameters and yield of ashwagandha to that of application of FYM @ 7 t ha^{-1}, vermicompost 3.5 t ha^{-1} and RDF. Application of organic inputs like (FYM, poultry manure, panchagavya, beejamrut and jeevamrut) with or without bio-fertilizers (*Azospirillum* + Phosphorus solubilizing bacteria) results in beneficial effect on growth and yield attributes of onion at Dharwad (Praveenkumar *et al.*, 2010). Baban (2011) reported that application of FYM @ 2.5 t ha^{-1} + vermicompost @ 1 t ha^{-1} + jeevamrut @ 500 litre ha^{-1} at 30 and 45 DAS significantly increased the maximum plant height (303.78 cm), number of branches $plant^{-1}$ (40), leaf area $plant^{-1}$ (18075.2 dm^2) of pigeon pea crop over control. Gore and Sreenivasa (2011) found that the significantly maximum plant growth and root length were recorded with the application of RDF + beejamrut (seed treatment by dipping for 10 minute) + jeevamrut at transplanting (500 litre ha^{-1}) + panchagavya (3 per cent) was sprayed at 25th, 70th and 100th day after sowing and it was found to be significantly superior over other treatments. The application of beejamrut + jeevamrut + panchagavya was next best treatment and resulted in significantly maximum yield as compared to RDF alone. Pawar *et al.* (2013) reported that the application of vermicompost 2.5 t ha^{-1} + jeevamrut + farmyard manure @ 5 t ha^{-1} at 30 and 45 DAS to *kharif* sweet corn recorded significantly higher cob and green fodder yield of sweet corn. Microbial count of bacteria, fungi and virus also increased significantly in this treatment over control. At Navsari (Gujarat), Patel (2014) observed that growth parameters of onion differed significantly at all the stages of crop growth. At 90 days after transplanting, maximum plant height (61.9 cm) and number of leaves $plant^{-1}$ (9.4) in the treatment supplied with 33% RDN each from bio compost, castor cake and vermicompost + jeevamrut @ 200 l ha^{-1} were noticed. Divya and Mahapatra (2015) revealed that combined application of enriched compost (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDF + FYM in combination with foliar application of jeevamrut @ 500 litre ha^{-1} at planting, 30 and 60 DAS + panchagavya @ 5 per cent at panicle emergence and flowering stages recorded significantly higher growth parameters of aerobic rice with higher grain yield (3837 kg ha^{-1}) and straw yield (5855 kg ha^{-1}) which was on par with control treatments *i.e.*, RDF + FYM and RDF only.

Rajamani *et al.* (2015) observed that the plant treated with 45 ml drumstick fermented leaf juice along with 3 g consortium, 50 ml jeevamrut and 5 ml humic acid significantly increased number of leaves (164.63), flowers (20.13), fresh shoot weight (162.125 g), dry shoot weight (25.49 g), dry root weight (14.71 g) and root volume (79.38 cm^3) of tomato than control. Application of 100 per cent N equivalent compost along with recommended dose of FYM 10 t ha^{-1}, jeevamrut 500 litre ha^{-1} at flowering and beejamrut 200 litre ha^{-1} significantly increased the plant height (70.13 cm), number of leaves (63.53), number of branches (8.47), seed yield (1740 kg ha^{-1}) and stover yield (1864 kg ha^{-1}) of cowpea (Yogananda *et al*., 2015). Basavaraj *et al.* (2015) studied the combined effect of FYM and liquid manures (jeevamrut and panchagavya) on growth and yield of french bean. Soil application of jeevamrut (1000 litre ha^{-1}) and foliar spray of panchagavya (3 %) gave significantly higher plant height (26.7 and 26.6 cm), number of branches (6.93 and 6.89), leaf area (1325 and 1263 cm^2), number of pods $plant^{-1}$ (15.89 and 15.40), pod weight $plant^{-1}$ (81.58 and 79.42 g) and green pod yield (141.7 and 138.7 q ha^{-1}) of french bean as compared to without jeevamrut (25.0 cm, 6.28, 991.0 cm^2, 13.18, 67.30 g and 117.0 q ha^{-1}, respectively) and without panchagavya application (25.1 cm, 6.32, 1054.0 cm^2, 13.67, 69.56 g and 120.0 q ha^{-1}, respectively). The application of FYM + vermicompost (50 per cent each) + jeevamrut 2 times (30 and 45 DAS) significantly increase plant height (63.21 cm), mean leaf area (5.01 dm^2), dry matter (36.71 g), seed yield (24.72 q ha^{-1}) and halum yield (31.24 q ha^{-1}) of soybean at Rahuri, Maharashtra (Patil and Udmale, 2016). Atal (2017) studied that combined application of vermicompost @ 7 t ha^{-1} along with jeevamrut (drenching + foliar spray) resulted in significantly maximum plant height (66.00 cm), number of branches $plant^{-1}$ (3.20), leaf area (85.39 cm^2), fruit weight (59.33 g), number of fruits $plant^{-1}$ (29.13), fruit yield $plot^{-1}$ (24.73 kg) and fruit yield (366.42 q ha^{-1}) of bell pepper. However, FYM @ 10 t ha^{-1} + vermicompost 3.5 t ha^{-1} along with jeevamrut recorded highest TSS (6.20°B) and ascorbic acid content (181.33 mg $100g^{-1}$). Vermicompost @ 7 t ha^{-1} along with jeevamrut recorded 82.4 per cent increase in yield of bell pepper over control along with increase in soil available NPK contents and NPK uptake.

Effect on yield attributes and yield

Somasundaram *et al.* (2003) observed non-significant difference in number of pods $plant^{-1}$ of green gram but significant effect on number of seeds pod^{-1} in green gram due to foliar application of panchagavya. The results are also in agreement which were obtained by Shwetha (2008) in soybean and Kumar *et al.* (2011) in blackgram who reported higher number of pods $plant^{-1}$, number of seeds pod^{-1} and test weight with the use of beejamrut, jeevamrut and panchagavya as organic source of nutrients. Kesarwani (2007) opined that the application of beejamrut as seed treatment + jeevamrut as soil application + straw mulch improved the ear head weight $plant^{-1}$, 100 grain weight and total biomass production of sweet sorghum. Chandrakala (2008) reported that the application of beejamrut + jeevamrut

+ panchagavya and panchagavya alone both at 120 DAT and 160 DAT recorded significantly higher dry chilli yield (8.52 and 8.01 q ha^{-1}, respectively) over control (6.40 q ha^{-1}). Shwetha (2008) conducted an experiment to know the effect of management of nutrients through organics in soybean-wheat cropping system in medium deep black clay loam soil. They reported a significant improvement in plant height, accumulation of dry matter, number of branches, leaf area index (LAI) and seed yield. With the application of organic manures in combination with fermented organics *viz.*, beejamrut, jeevamrut and panchagavya over organics alone application, the yield parameters like number of pods plant^{-1} were significantly higher. At Dharwad (Karnataka), Venkanna (2008) reported that the application of glyricidia loppings @ 10 t ha^{-1}, crop residues @ 10 t ha^{-1} along with FYM + organic solutions *i.e.*, amrutpani and jeevamrut (860.70 kg ha^{-1}, 830.83 kg ha^{-1}, respectively) recorded at par yield of chilli as that of FYM @ 10 t ha^{-1} + RDF (935.45 kg ha^{-1}). Baban (2011) conducted a field experiment and reported that the application of FYM @ 2.5 t ha^{-1} + vermicompost @ 1 t ha^{-1} + jeevamrut @ 500 litre ha^{-1} at 30 and 45 DAS significantly increased number of pods plant^{-1} (137.11), number of seeds pod^{-1} (4.0), seed weight plant^{-1} (71.94 g), seed yield (26.64 q ha^{-1}), stalk yield (54.67 q ha^{-1}), protein content (21 %) and protein yield (5.59 q ha^{-1}) of pigeonpea over control. Gore and Sreenivasa (2011) studied the effect of liquid organic manures on growth, nutrient content and yield of tomato in sterilized soil and reported that the application of RDF + beejamrut (seed treatment by dipping for 10 minutes) + jeevamrut (500 litre ha^{-1}) at transplanting + panchagavya (3%) sprayed at 25th, 70th and 100th day after sowing resulted in higher fruit yield of tomato (23.25 fruits plant^{-1}). Ravi *et al.* (2011) studied the effect of organic sources of nutrients on quality of groundnut at UAS, Bengaluru (Karnataka) during *kharif* season. They recorded higher oil and protein content and yield under the treatment, application of FYM @ 7.5 t ha^{-1} + jeevamrut (N equivalent) + *Rhizobium* + PSB as compared to application of FYM only. Boraiah (2013), reported that application of jeevamrut resulted in 7.98 to 26.20 per cent increase in fruit yield of chilli as compared to without jeevamrut application. This might be due to higher number of fruits plant^{-1} (43.99 to 56.31), fruit length (6.82 to 7.43 cm), total dry matter plant^{-1} (10.46 to 15.67 g), fruit girth (16.81 to 17.19 cm) and fruit weight plant^{-1} (126.12 to 125.67 g). At Akola (Maharashtra), Patil *et al.* (2014) reported that plant height, number of branches plant^{-1}, number of compound leaves, leaf area plant^{-1}, seed and stalk yield of pegion pea significantly increased due to application of FYM @ 2.5 t ha^{-1} + vermicompost @ litre t ha^{-1} + jeevamrut @ 500 litre ha^{-1} at 30 and 45 DAS was predominant on control. At Navsari (Gujarat), Patel (2014) concluded that yield as well as quality parameters of onion were significantly influenced by different treatments. Application of 33 per cent RDN each from bio compost, castor cake and vermicompost + jeevamrut @ 2000 litre ha^{-1} recorded the highest bulb weight (61.4 g), but highest dry bulb yield (5.12 t ha^{-1}) and dry leaves yield (2.77 t ha^{-1}) recorded with the application of 100% RDN from nadep compost + jeevamrut 2000 litre ha^{-1}. Basavaraj *et al.* (2015) reported that soil application of jeevamrut recorded significantly higher pod yield of french bean (141.7 q ha^{-1}) compared to without jeevamrut application (117 q ha^{-1}) and foliar spray of panchagavya @ 3 per cent recorded significantly higher pod yield (138.7 q ha^{-1}) compared to without panchagavya spray (120 q ha^{-1}). Divya and Mahapatra (2015) concluded that among organic treatments combined application of enriched compost (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDF + FYM in combination with foliar application of jeevamrut @ 500 litre ha^{-1} at planting, 30 and 60 DAS + panchagavya @ 5 per cent at panicle emergence and flowering stages recorded significantly higher growth parameters of with higher grain yield (3837 kg ha^{-1}) and straw yield (5855 kg ha^{-1}) of aerobic rice which was on par with control treatments *i.e.,* RDF + FYM and RDF only. Boraiah *et al.* (2017) reported that fruit yield hectare^{-1} of capsicum varied significantly due to the application of jeevamrut. Higher yield of capsicum was recorded with application of jeevamrut @ 500 litre ha^{-1} at 60 DAT (32.26 q ha^{-1}), 70 DAT (39.55 q ha^{-1}), 80 DAT (51.63 q ha^{-1}), 90 DAT (121.20 q ha^{-1}), 100 DAT (100.28 q ha^{-1}), 110 DAT (86.40 q ha^{-1}) and 120 DAT (50.05 q ha^{-1}).

Potkile *et al.* (2017) conducted a field experiment during *kharif* and *rabi* for two consecutive years (2010-11 and 2011-12) to evaluate the direct and residual effect of various organic manures and crop residues alone and along with jeevamrut on productivity and economics of soybean-wheat cropping system. Three organic manures (FYM, vermicompost and compost) alone and along with jeevamrut, three crop residues (cotton, wheat and soybean) @ 5 t ha^{-1} along with jeevamrut were incorporated in soil one month before sowing to both soybean and wheat crop. Only nitrogen level was balanced through manures and no phosphorus and potash were applied, jeevamrut was applied @ 500 litre ha^{-1} at 30 DAS and 45 DAS. The pooled results of two years revealed that significantly higher soybean seed equivalent yield (33.48 q ha^{-1}), production efficiency (19.41 kg day^{-1} ha^{-1}) and economic efficiency (₹ 301.87 day^{-1} ha^{-1}) of system. Hameedi *et al.* (2018) reported that the application of vermicompost @ 7 t ha^{-1} along with jeevamrut (applied as 3 drenching with jeevamrut @ 5 per cent at 15 days interval started at the time of transplanting + 2 foliar spray of jeevamrut @ 3 per cent at 15 days interval started after 45 days of transplanting) significantly influenced growth and yield attributes of bell pepper and recorded 82.4 per cent increase in yield over control along with less incidence of insect-pest and diseases. Safiullah *et al.* (2018) reported significantly higher plant height, cob weight plant^{-1}, green cob (16145 kg ha^{-1}) and fodder (20068 kg ha^{-1}) yield; cob length and cob and stem girth of sweet corn was noted with application of jeevamrut, panchagavya and sanjeevak @ 600 litre ha^{-1}, respectively. The higher total reducing (3.19%) and non-reducing sugar (19.57%) content were recorded under the treatments panchagavya and jeevamrut, receiving panchagavya and jeevamrut @ 600 litre ha^{-1}).

Spehia *et al.* (2018) studied the effect of Hoagland Nutrient Solution (HNS) and jeevamrut on growth, yield and quality of lettuce using Nutrient Film Technique compared to grow bags. Treatment with Hoagland Nutrient Solution + 5% application of jeevamrut in Nutrient Film Technique increased numbers of leaves, root length, leaf area and yield by 40, 34, 24 and 24%, respectively, over the control (fertigation with Hoagland Nutrient Solution in grow bags). The water used for hydroponics was 22 times less compared to grow bags. Growing lettuce in hydroponics fertilized with Hoagland Nutrient Solution + 5% application of jeevamrut using the Nutrient Film Technique produced good quality lettuce with higher yield.

Effect on nutrient uptake and quality

Chandrakala *et al.* (2007) recorded significantly higher uptake of N, P and K (60.61, 12.98 and 102.74 kg ha^{-1}) by combined application of beejamrut + jeevamrut + panchagavya and increased dry fruit yield of chilli (8.52 q ha^{-1}) as compared to beejamrut + jeevamrut application. They also reported that combined application of FYM and beejamrut + jeevamrut + panchagavya recorded significantly higher dehydrogenase activity (30.00 and 25.67 mg TPF g^{-1} soil at 120 and 160 DAT, respectively) in capsicum. Venkanna (2008) studied the effect of mulches, organics and organic solutions on the growth, yield and quality of chili at main agricultural research station, UAS, Dharwad. The application of amrut pani recorded at par nitrogen and potassium uptake (74.19 kg ha^{-1}) and (76.70 kg ha^{-1}) as that of jeevamrut (73.76 kg ha^{-1}) and (76.02 kg ha^{-1}), respectively. Manjunatha *et al*. (2009) studied the comparative effect of jeevamrut and farm yard manure on yield attributes, yield and economics of sunflower. Application of FYM @ 7.5 t ha^{-1} + 100 per cent RDF, significantly increased the test weight (49.26 g), seed yield (1774 kg ha^{-1}) and stalk yield (4.21 t ha^{-1}) compared to control (36.62 g, 851 kg ha^{-1}, 2.83 t ha^{-1}, respectively). However, this treatment was found at par with FYM @ 7.5 t ha^{-1} + jeevamrut 500 l ha^{-1}.

Baban (2011) reported that the application of FYM @ 2.5 t ha^{-1} + vermicompost @ one tonne ha^{-1} + jeevamrut two times @ 500 litre ha^{-1} (30 and 45 DAS) significantly increased available N (170.92 kg ha^{-1}), available P (9.31 kg ha^{-1}), available K (426.53 kg ha^{-1}), organic carbon (0.50 %) and their uptake by the pigeonpea crop as compared to all other treatments and control. Gore and Sreenivasa (2011) observed that the application of liquid organic manure + RDF followed by beejamrut (200 litre ha^{-1}) + jeevamrut (500 litre ha^{-1} at transplanting) + panchagavya (500 litre ha^{-1}) applied at 25th, 70th and 100th day after sowing recorded significantly higher nutrient uptake *viz.*, N, P and K in tomato crop (4.38 kg ha^{-1}, 0.43 kg ha^{-1} and 1.03 kg ha^{-1}, respectively) as compared to application of beejamrut, jeevamrut and panchagavya (3.36 kg ha^{-1}, 0.35 kg ha^{-1} and 1.087 kg ha^{-1}, respectively). Significantly lower uptake of NPK was observed with control (2.4 kg ha^{-1}, 0.23 kg ha^{-1} and 0.76 kg ha^{-1}, respectively). Azin and Dhumal (2012) studied the effect of organic manure on growth, yield and nutrient quality of tomato at Pune (Maharashtra). Two different farms were selected; For organic farm, jeevamrut was used which contains neem cake (2 kg) magnesium sulphide (3 kg), cow dung (10 kg), jaggery (2 kg) and cow urine (5 litre). The organic manure like FYM and compost were added as per the recommended dose before preparation of land. For inorganic farm only chemical fertilizers were added. Tomato grown under organic farm recorded significantly higher N, P, K and micronutrient uptake, protein, carbohydrates, total sugars, energy value and vitamin C than tomato grown under inorganic farm.

Channagoudra and Babalad (2012), studied the application of organic manures, crop residues, green manures and liquid organic manure on yield of organic cotton and soil health. The results of two years revealed that combined application of compost (50%) + vermicompost (50%) + green leaf manure (*Gliricidia*) with surface application of jeevamrut @ 500 litre ha^{-1} recorded significantly higher soil organic carbon (6.0 g kg ha^{-1}), available N (288.1 kg ha^{-1}), P_2O_5 (31.2 kg ha^{-1}) and K_2O (335.5 kg ha^{-1}), respectively). Divya and Babalad (2012) observed that application of organic inputs like jeevamrut and panchagavya significantly increased grain yield (3387 kg ha^{-1}) and straw yield (4632 kg ha^{-1}) with higher uptake of N, P, K and micro-nutrients (Fe, Mn, Zn and Cu), higher available soil nutrients after harvest of aerobic rice. Praveen *et al*. (2012) studies the organic farming practices in onion at UAS, Dharwad (Karnataka) during *kharif,* 2009. Supplementation of nutrients through organic inputs like (FYM, poultry manure, panchagavya, beejamrut and jeevamrut) with or without bio-fertilizers (*Azospirillum* + Phosphorus solubilizing bacteria) resulted in higher TSS, longer shelf life, less per cent of rotting, sprouting and diseases infestation in onion as compared to integrated nutrient management. Further, storage loss was reduced when onion was supplemented with beejamrut and jeevamrut. Ravi and Basavarajappa (2012) studied the effect of integrated nutrient management in quality protein maize and observed the combined effect of 75 per cent RDF + sunnhemp incorporation at 40 DAS + biofertilizer seed treatment (*Azospirillum* + PSB) + panchagavya spray at tasseling and silking stage + jeevamrut soil application at 40 and 60 DAS increases soil available phosphorus (26.4 kg P_2O_5 ha^{-1}), available nitrogen (235.5 kg N ha^{-1}) and potassium (271.3 kg K_2O ha^{-1}).

Laharia *et al.* (2013) conducted experiment at PDKV, Akola (Maharashtra) on clay soil and results revealed that the application of 100% RDN through vermicompost + jeevamrut (30 and 45 DAS) recorded higher seed yield, straw yield and nutrient uptake in soybean as compared to other treatments but it was on par with 100% RDN through vermicompost, 100% RDN through FYM + jeevamrut (30 and 45 DAS). Shaikh and Gachande (2015) studied the effect of various liquid organic inputs and inorganic inputs on soil physico-chemical properties of jowar field. Results show that in organic inputs applied field, there is a significant increase in soil properties like organic carbon (0.11% to 0.34%), phosphorus (6.62 kg ha^{-1} to 15.16 kg ha^{-1}), water holding capacity (3.3% to 8.5%) over inorganic inputs applied field. However, there is significantly decrease in pH (0.79 to 1.23) and electrical conductivity (0.07 ms cm^{-1} to 0.36 ms cm^{-1}) of soil in organic field compared to inorganic field. The potassium content was higher in both fields. Atal (2017) mentioned that application of vermicompost @ 7 t ha^{-1} along with jeevamrut (drenching + foliar spray) in bell pepper recorded 82.4 per cent higher soil available N, P and K contents, N, P and K uptake and less incidence of pest and diseases. Jeevamrut and panchagavya contains nutrients as well as beneficial microbes which improve soil structure, fertility and radically improve biological diversity, suppress soil-borne pathogens, fixes the nitrogen in soil and enhances nutrient uptake, accelerates the decomposition of organic waste, residues and composting, increases beneficial minerals in organic compound, enhances the activities of indigenous microorganism and boosts the strength of plants and yield of crops (Joshi *et al*., 2019).

Effect on economics

Manjunatha *et al*. (2009) studied the comparative effect of jeevamrut and farm yard manure on yield attributes, yield and economics of sunflower. Application of FYM @ 7.5 t ha^{-1} + jeevamrut gave highest net return (`27,384 ha$^{-1}$) which was at par with the treatment of 100 per cent RDF (¹ 25,475 ha$^{-1}$) and was significantly superior over the treatment of FYM applied @ 3.75 t ha$^{-1}$ + jeevamrut (`24,405 ha^{-1}). Application of 100 per cent RDF recorded highest B-C ratio (3.74) which was at par with other treatments like FYM @ 7.5 t ha^{-1} + jeevamrut (3.72). Baban (2011) found that the maximum gross monetary return (`87,981 ha$^{-1}$) and net monetary return (`48,931 ha^{-1}) and benefit-cost ratio of pigeonpea (2.25) were recorded with the application of FYM @ 2.5 t ha^{-1} + vermicompost @ 1 t ha^{-1} + two times jeevamrut spray @ 500 litre ha^{-1} (30 and 45 DAS). Chandrarakala *et al.* (2011) studied the effect of FYM and fermented liquid manure on yield and economics of chilli and revealed that application of farm yard manure on N equivalent base + seedling dipping with beejamrut + jeevamrut @ litre ha^{-1} + two spray of panchagavya @ 3% recorded higher B-C ratio of 1.74 than application of only FYM (B-C ratio 1.39). Amareswari and Sujathamma (2014) showed that the yield of rice with application of jeevamrut was 2.77 t acre^{-1} in Masura and 2.62 t acre^{-1} in Hamsa variety of rice. These were 3.0 tons and 2.5 t acre^{-1} in chemical method of farming in respective varieties. It indicated that application of jeevamrut could yield better than chemical farming in Hamsa variety. But the cost of cultivation was 18 per cent higher in Masura and 19 per cent higher in Hamsa variety of rice when grown with recommended dose of fertilizers as compared to the production using jeevamrut. In both the varieties benefit-cost ratio was better with application of jeevamrut method being 3.39 in Masura variety and 3.0 in Hamsa as compared to 1.09 and 0.6 in chemical methods of rice production, respectively.

In Maharastra (India), Laharia *et al.* (2013) studied the effect of organic sources on net yield of soybean. They recorded higher gross (` 39767) and net (` 19884) income per hectare in the treatment of 100% RDN through vermicompost + jeevamrut, while higher B-C ratio (1.14) was recorded in the treatment of 100% RDN through FYM. Divya and Mahapatra (2015) also gained higher net return (` 36,366) with combined application of enriched compost (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDF + FYM with foliar application of jeevamrut @ 500 litre ha^{-1} at planting, 30 and 60 DAS + cow urine @ 10 per cent at panicle emergence and flowering stages and benefit-cost ratio (2.49) was higher with combined application of enriched compost (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN + cow urine @ 10 per cent at panicle emergence and flowering stages. Patil and Udmale (2016) recorded the maximum net monetary return under FYM + vermicompost (50% each) + jeevamrut 2 times (at 30 and 45 DAS) followed by jeevamrut 2 times (at 30 and 45 DAS) and benefit-cost ratio was higher where jeevamrut applied to soybean at 30 and 45 DAS. The combined application of vermicompost @ 7 t ha^{-1} along with jeevamrut (drenching + foliar spray) gave highest net return (`713,795 ha^{-1}) whereas, benefit-cost ratio (5.43) was highest with jeevamrut application (Atal, 2017). Potkile *et al.* (2017) found the maximum benefit-cost ratio (2.21) with 100% RDN through vermicompost + jeevamrut followed by 100% RDN through vermicompost.

CONCLUSION

Panchagavya and jeevamrut is farmer's best buddy and ideal for organic farming in India because they conceal the plants from danger or harm from soil, micro-organisms and enhance crop protection as well as production. Panchagavya is the supernatural fertilizer that works wonder for the health and growth of roots. It is highly advantageous than artificial chemical fertilizer applications and sprays. It is simple to prepare, comes at a cost easily reasonably priced by the peasants. The application of jeevamrut, panchagavya, beejamrut and other liquid organic manures on crops grown under organic farming practices significantly enhances the growth and yield attributes along with straw/haulm yield and quality of harvested produce, which will result in better economics of crops grown.

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