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Review on Organic Foliar Application – A Nutritional Boost to Pulse Productivity

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ABSTRACT

India is the world's top producer and consumer of pulses. The area under pulse crop is increasing continuously but productivity is decreasing over years. Reduced production is caused by a lack of care, an uneven fertilizer application and the emergence of physiological problems, particularly inefficient assimilate partitioning, poor pod development, excessive flower abscission due to the nutrient stress. Foliar nutrition is an efficient way of supplementing the available plant nutrients when they lack in the soil. Organic fertilizers are mainly used to stimulate growth by providing proper nutrients at the right dose and proper stage of the crop growth. Liquid organic manures are the source of macronutrients, necessary micronutrients, required amino acids, growth promoting factors and certain beneficial microorganisms. There is an opportunity for increasing pulse yield and quality by raising soil fertility and productivity by increased ability of conservation of soil organic carbon and soil moisture.

Keywords Foliar nutrition, Jeevamrutha, Liquid manures, Organic, Pulses, Vermiwash.

INTRODUCTION

Pulses are important in Indian agriculture for long-term production, improved soil health and environment security. Pulses, also known as food legumes, are a low-cost alternative to cereals in terms of production and consumption in India. They play a vital role in Indian agriculture as they restoring soil fertility by atmospheric nitrogen fixation by root nodules. Pulses are low water use crop and due to their deep root system and strong ground coverage controls soil erosion. Pulses are referred as "poor man's meat" since they are less expensive than meat with higher protein content. Pulses are an important element of farmers' cropping systems across the country since they fit well in different crop mixing and crop rotation. With 32% of the world's land area and 25% of the world's output, India is both the world's major producing and consuming country among pulses.

Foliar fertilization, also known as foliar feeding, entails the delivery of nutrients, plant hormones, stimulants and other growth promoting substances

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in liquid form to plants through aerial parts of the plants, such as leaves and stems in order to improve yield and quality, pest resistance, drought tolerance and plant regeneration from transplant shock, hail damage and other weather extremes. Foliar method of nutrient application can improve nutrient utilization and reduced environmental pollution by reducing the need of chemical fertilizers application in soils (Abou El-Nour 2002).

The soil application of nutrients alone cannot fulfill the nutrient requirement of crops. Hence, for an additional supply of nutrients, there's a demand to use liquid organic fertilizers which can supply adequate macro and micro nutrients at the critical stage of the crop as well as have insecticidal or fungicidal properties (Sutar *et al.* 2019). Organic fertilizers are mainly used to stimulate growth by providing proper nutrients at the right dose and proper stage of the crop growth. Apart from using conventional farm based products, there's a rising interest in liquid organic solutions viz., jeevamrutha, cow urine, bio digester filtrate and vermiwash which help in increased action of topsoil small flora and fauna results in a rapid increase in soil fertility.

Crop productivity may be increased in an organic production system by optimizing the nutritional requirements of the crop at various stages. For enhancing soil productiveness and production, organic systems rely on organic matter management. Beejamrutha, jeevamrutha and panchagavya are liquid organic solutions made from cow dung, urine, milk, curd, ghee, pulse flour and jaggery. There is an opportunity for increasing pulse yield and quality by raising soil fertility and productivity by increased ability of conservation of soil organic carbon and soil moisture (Palekar 2006).

Dryland agriculture in India and its relationship with pulse production

Out of 159.7 m ha of arable land in the country, 47% comes under net irrigated area in which remaining fall under rainfed ecology. This dryland agriculture supports to the 40% of human and 60% of the livestock population and importantly more than 44% of food requirement of the country was supplied through drylands which helps in the nutritional security of the country (Sridhara 2022). The major crops grown in the dryland are sorghum, oilseeds, pearl millet and pulses. Among the crops grown, pulses are very important because of more than 90% grown under rainfed and reamining 10-15 % was grown under irrigated condition. Rahman *et al.* (2015) stated foliar fertilization is more appropriate for *rabi* pulses since fertilizers are difficult to apply by top dressing or placement.

The major hurdles of dryland agriculture are; environmental stress, degraded soils, moisture stress and multiple nutrient deficiencies. These nutrient deficiencies can be rectify through the agro techniques like foliar feeding when moisture is deficit for soil uptake of nutrients from soil. As we know Indian agriculture condition that, where there is scope for vertical development only i.e., increasing production and productivity and not horizontal development i.e., increasing the area under cultivation.

Foliar nutrition

Foliar feeding is the process of delivering fertilizer solutions on the foliage of plants. Essential elements may be absorbed by plants through their leaves. Both their stomata and their epidermis are used for the absorption (Patil *et al.* 2012). This approach is ideal for applying little amounts of fertilizers, particularly micronutrients. When there is insufficient moisture in the top layer of the soil for absorption, this technique can also be used to provide major nutrients. In agriculture, this technique is used to spray the leaves with diluted solutions containing the desired nutrients.

Some liquid organic manures used in the crop production for foliar application

Jeevamrutha

Take 200 liters barrel of water, add 10 kg fresh desi cow dung and 10 liters cow urine. Add 2 kg powdered jaggery, 2 kg pulse flour and a handful of top fertile soil from below the tree/band of the farm/forest. Mix the ingredients well and store it in shade with gunny bag cover. Stir the contents in morning, afternoon and evening in clock wise direction using wooden pole

for 7 days and use jeevamrutha as a fresh material. This mixture is useful for one time application for one acre crop.

Bio digester filtrate

The bio digester filtrate was prepared in a 200 litre barrel with 10 kg cow dung, cow urine 10 kg, a little volume of soil and 5 kg each of botanicals like neem, lantana and custard apple and then the volume was increased to 200 liters by adding water. It was kept to fermentation for two weeks, with daily stirring. In two weeks, the digested liquid manure was ready to use as a foliar spray.

Cow urine

Cow urine is a rich source of mineral nutrients that is generally disposed as waste by farmer households. Farmers may obtain this nutritional supply to plants for free in their own homes. It was obtained directly from cow one day before spraying for the crop and used in the experiments by diluting with water at desired rate.

Vermiwash

Vermiwash may be collected from the vermicompost units as a by-product liquid extract and another method for the preparation of vermiwash with organic waste and earthworms in a container of 15 to 20 liters capacity and the base of the container is attached to the tap.

Panchagavya

Panchagavya was formed by blending 7 kg fresh cow dung with 1 kg ghee and incubating it in a plastic barrel for two days by mixing it once a day. After, 10 l water and 10 l desi cow urine was included and mixed carefully and incubated for 13 days for fermentation. The contents were then added, along with 3 liters milk, 2 liters curd, 100 g yeast, 3 liters tender coconut water, 3 kg jaggery and 12 ripened Cavendish bananas and the concoction was incubated for 6 days by stirring thoroughly three times a day. The contents of the plastic drum were maintained in the shade and covered with a moist jute bag. After fermentation for 21 days, the liquid was filtered through a cotton cloth and applied at desired rate.

Neem seed extract

Fresh neem seed were gathered and dried in shed before taking weight. The weighed seeds were then crushed and 5 kg fresh neem seed with 15 liter of water is kept in earthen pot for two weeks by covering with cloth. These extracts were then filtered using a fine muslin cloth to obtain a volume of 100 liters. This liquid should be maintained at room temperature.

Fish wash

The fish wash extract was prepared with 100 liters of regular water. The water will be poured with fourty pieces of fish. The fish should be maintained in the water for 6-8 hrs. Following that, all of the fish should be taken from the tub and water should be collected for spraying at the desired concentration. Average nutrient composition of some liquid manures are given in the Table 1.

Importance of liquid organics in foliar nutrition

The fermented liquid organic manures prepared from various plant and animal products like panchagavya, jeevamrutha, beejamrutha, sasyamrutha, vermiwash, amritpani.

According to Gadewar *et al.* (2013) observed that the application of concoctions like vermiwash, jeevamrutha and beejamrutha results improved growth and productivity. Shivsubramanian and Ganesh (2004) observed that vermiwash is made up of enzymes and earthworm secretions that can boost crop development and productivity, as well as build resistance in crops that are sprayed solution.

Zambare *et al.* (2008) reported that vermiwash was found to contain enzyme cocktail of urease, amylases, proteases and phosphatase. According to a microbiological examination, vermiwash includes nitrogen-fixing bacteria such as *Agrobacterium* sp. *Azotobacter* sp. and *Rhizobium* sp. as well as phosphate-solubilizing bacteria. Both major and micro nutrients were present in liquid organic manures in

Table 1. Nutrient composition of some liquid organics manures (Sridhara 2022).

Organics	N (%)	P (%)	K (%)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Mg (ppm)	IAA (ppm)	GA_3 (ppm)
Vermiwash	0.18	0.14	0.32	0.03	0.35	2.21	0.04	6.21	5.43	3.50
Cow urine	1.10	0.10	1.51	-	18.00	578.00	300.00	6.30	-	-
Jeevamrutha	1.35	0.16	0.31	4.29	51.00	282.00	10.70	46.00	7.90	4.50
Bio digester filtrate	0.47	0.13	0.21	0.52	1.24	9.60	8.30	-	-	-
Panchagavya	1.39	0.08	0.5	1.27	0.38	29.71	1.84	-	8.50	3.50

addition to micro flora (Sreenivasa *et al.* 2011). Devakumar *et al.* (2014) reported that jeevamrutha formulation having a pH of 4.92, contained nutrients like nitrogen, phosphorus and potassium (1.96 %, 0.17% and 0.28 % respectively) and also Mg (46 ppm) and Cu (51 ppm). They also noticed that higher microbial population was recorded between 9th and 12th day of the preparation. After that, it started to decline as the days pass. The plant growth promoting bacteria (*P. flourescens*), rhizosphere fungi (*Trichoderma* spp.), and endophytic fungi (*M. anisopliae* and *B. bassiana)* found in natural products and concoctions could act as plant bio stimulants as reported by (Sridevi *et al.* 2018). Korat and Dengale (2011) reported that the cow urine acts as a nutrient as well as plant growth hormone and believed to serve as repellent for insects pests. Because of the immunostimulant function, its usage on crops offers insect resistance and boosts total crop productivity. Mallesha (2017) opined that, soil application of organic manures and foliar application of liquid organic manure produced significantly higher micro flora and better soil health compared to the application of inorganic fertilizer.

Vermiwash

Nath *et al.* (2009) concluded that the vermiwash of different combination of animal, agro and kitchen wastes have better growth and productivity of crops. Vermiwash is cheaper than chemical fertilizers. It is easy to make, environmental friendly and one of the best liquid organic manures for foliar spraying to various crops.

Esakkiammal *et al.* (2015) reported that the combination of vermicompost and vermiwash showed maximum positive effects and significant variations in the growth and yield parameters of lablab beans. Earth worms extract application recorded higher number of branches (3.23) over water spray (2.96) and the mean grain yield was significantly higher with vermiwash (10.42 q ha^{-1}) compared to water spray (9.68 q ha^{-1}) as reported by Khairnar and Gunjal (2012).

The combined use of 100 % recommended dose of fertilizer + vermiwash, significantly improved growth parameters, yield attributes like number of pods per plant (142.33), grains per pod (4.09) and test weight (108.05 g), straw yield, gross returns, and net returns, while BC ratio was highest under 100% RDF in combination with cow urine in pigeonpea at Varanasi (Verma *et al*. 2018). Chauhan and Singh (2014) reported that significant increase in germination, production and productivity of chickpea was observed with regard to control later application of vermiwash aqueous neem extract. Among three different concentrations of vermiwash and panchagavya (5.2, 10.3 and 15.4 %), spraying of 10.3% vermiwash and panchagavya treated plants showed better growth promoting effects in terms of morphological characters such as shoot length and growth paramets in lablab (*Dolichus lablab*) as opined by Maheshwari *et al.* (2016).

Panchagavya

In Ayurveda, the term panchagavya refers to five vital substances obtained from cow viz., cow urine, cow dung, ghee, milk and curd. Ayurveda describes the use of panchagavya components alone or in conjunction with herbal, animal or mineral treatments in a multitude of formulations. It consists of macro (N, P, K and Ca) and micro (Zn, Fe, Cu, Mn) nutrients (Papen *et al*. 2002), growth promoting enzymes along with essential plant nutrients.

Yadav *et al.* (2017) showed 3% spray panchagavya remained on par with vermiwash 10% and also recorded significantly tallest plant (54.48 cm), total number of root nodules (39.78 plant^{-1}), effective root nodules (35.10 plant^{-1}), dry matter accumulation (17.90 g plant^{-1}), pods (49.54 plant^{-1}), seed yield (1888 kg ha^{-1}) and haulm yield (2804 kg ha^{-1}) as compared to cow urine and control respectively in chickpea. Reshma *et al.* (2016) and Sumalata (2015) reported that foliar spray of panchagavya @ 7.5% recorded significantly higher plant growth parameters like plant height (61.41 cm), more number of branches (7.63), number of leaves (24.16), leaf area (929.38 cm^2) and leaf area index (1.38) in cowpea.

Kumaravelu and Kadamban (2009) observed in pot study that panchagavya @ 3% foliar application after 10 days of sowing improved the growth of green gram plants. Application of 3 % panchagavya has appreciable influence on the lateral roots density, nodules per plant, fresh and dry matter distribution and total leaf area of the plants. Jadhav and Kulkarni (2016) revealed spraying of liquid organic fertilizers like panchagavya @ 5%, vermiwash @ 5% and cow urine @ 5% increased attributes of green gram crop over control treatment under North Eastern transitional zone of Karnataka.

Panchagavya spray as bio-manure recorded higher mean number of leaves (26.45), dry shoot weight (2.57), fresh shoot weight (7.99), root length (26.45), dry root weight (2.58), fresh root weight (7.99) and plant height (26.45) compared to control in Pea (Shiri *et al.* 2020). The 6% panchagavya spray at flower initiation stage + soil application of jeevamrutha @ 500 l ha^{-1} at 20 days after sowing of cowpea along with 75% recommended dose of fertilizers documented outstandingly supreme root nodules per plant, seed yield and haulm yield in cowpea (Desai *et al*. 2014).

Jeevamrutha

Pathak and Ram (2007) reported that the jeevamrutha was made with cow dung, 10 liter cow urine, jaggery (2 kg / 4 L sugar cane juice), fertile soil (1 kg), pulse flour (2 kg) and water (20 L) in a tank (plastic/earthen/cement) under the natural farming technique of agriculture and its application to soil after 5th day of its preparation encouraged the growth of beneficial microorganisms in soil like *Azospirillum*, PSM, *Pseudomonas, Trichoderma,* yeast and moulds. Devakumar *et al.* (2014) showed that nutrient composition of jeevamrutha formulation having a pH of 4.92, nutrients like nitrogen 1.96%, phosphorus 0.28 per cent and potassium 0.17% and also contains micro nutrients like Mg 46 ppm and Cu 51 ppm.

When compared to other organic treatments for black gram, the foliar application of jeevamrutha @ 3% (every 10 days) reported greater crop growth rates, net assimilation rates, leaf area index, and leaf area duration, which stem and specific leaf weight (Bhargavi *et al.* 2020). Saraswathi (2020) reported the effect of ghanajeevamrutha along with liquid manure treatments combination in chickpea at Vijayapura. Results showed that treatment 100% ghanajeevamrutha + jeevamrutha 10% recorded superior results over other treatments but it was comparable with treatment receiving 75% ghanajeevamrutha + jeevamrutha 10%.

Sridhara *et al.* (2022) reported that jeevamrutha spary to the leaves at a rate of 25% both before blooming and at pod commencement in chickpea recorded taller plant (33.3 cm) and significantly higher number of branches (6.27), total dry matter production per plant (18.38 g plant^{-1}), leaf area (2.09 dm^2), leaf area index (0.47), crop growth rate (84.07 mg dm^{-2}), relative growth rate (17.38 mg g^{-1}) and absolute growth rate (0.37 g plant^{-1}) over other treatment combinations. Foliage spray of bio digester filtrate @ 25% and 50% and jeevamrutha @ 25% in combination significantly resulted higher pods plant^{-1} (24.29), seeds per pod (17.64), test weight (11.92 g), pod yield (1876 kg ha^{-1}), seed yield (1470 kg ha^{-1}) and haulm yield (3867 kg ha^{-1}) and was on par with the foliar application of bio digester filtrate @ 25% and jeevamrutha @ 50% in combination in cowpea (Praveena 2021).

Cow urine

Deotale *et al.* (2011) stated that spraying of 6% cow urine in soybean, recorded outstandingly superior plant height (34.83 cm) and dry matter production per plant (17.02 g) over water spray (29.88 cm and

14.07 g, respectively). Similar results were observed with the application of bio digester and 10% cow urine spray as against without spray (Patel *et al.* 1999). Hanumantappa *et al.* (2015) revealed application of FYM at 5 t ha^{-1} along with poultry manure equivalent to 25 kg N ha^{-1} and cow urine at 25 and 50 DAS recorded significantly higher seed yield (1064 kg ha^{-1}) in black gram. The use of bio-fertilizer and organics (cow urine 33 %) sprayed at 25 DAS and 45 DAS produced the highest pods number per plant (79.05) and test weight (50.05 g) which in succession resulted in the highest yield (1481 kg ha^{-1}) when compared to control in green gram (Thomas and Lal 2003).

Pawar *et al.* (2008) observed that cow urine foliar spray @ 4, 6, 8 and 10% along with NAA @ 50 ppm recorded remarkably higher yield of 24.74 q ha^{-1} along with increased chlorophyll content, nitrogen, leaf potassium and kernel oil content in Chickpea. Application of cow urine @ 10% on chickpea at flower initiation and 15 days after flowering recorded higher plant height (35.78 cm), branches $plant^{-1}$ (4.82), leaf area index (1.30) and pods $plant^{-1}$ (60.86) at harvest over control (Patil *et al.* 2012).

Neem extract and fish wash

Salako *et al.* (2008) revealed that neem leaf and seed powder or extracts reduced weevil activity in stored maize and cowpea and increased seedling robustness and germination rates. In addition, the treated cowpea plots yielded a considerable increase in grain output (409 kg ha^{-1}) over control plots 301 kg ha^{-1}. It also minimized fungal infection and damage on stored seeds and field crops. Lokanadhan *et al.* (2012) reports, neem seed cake serves as both a fertilizer and a pesticide, enriches soil, inhibits the growth of soil pests and bacteria, supplies macronutrients necessary for all plant growth and contributes to long-term increases in plant yield. It is also biodegradable, environmentally friendly, and a great soil conditioner. Similar results are also reported by Moyin-Jesu (2014).

Myint *et al.* (2009) stated foliar spray including fish waste extract @ 40 cc/ 20 liter of water on soybean crop showed that higher plant height, leaf length, plant dry weight and seed yield observed as compare to control. Without harming fish output, fish effluents can be used to replenish organic manure for agricultural cultivation. Balraj *et al.* (2014) showed fermented fish waste enriches soil nutrients needed for plant growth and positively affects the conducting abilities of xylem and phloem vessels, according to research. As a result, fish excrement might be utilized as a beneficial organic liquid fertilizer to increase agricultural output at a lower cost and without the undesirable side effects of chemical fertilizers. Similar results are also reported by Jain (2011).

CONCLUSION

Black gram, green gram, cowpea, chickpea and pigeonpea can all benefit from the foliar application of panchagavya, cow urine, bio digester filtrate or vermiwash at blooming and 15 days following in order to increase seed output. The growth, yield characteristics and yield of pulses are significantly influenced by the foliar application of liquid organic manures because it provides vital micronutrients and growth hormones. Natural preparations and concoctions containing plant growth-promoting bacteria, rhizosphere fungi and endophytic fungi that function as plant bio inoculants. Use of organic concoction solutions were environmentally safe and economically feasible.

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