

STUDIES ON INDIGENOUS COW (*BOSINDICUS*) BASED BIO-ORGANIC FORMULATIONS (BOFS) IN TOMATO CULTIVATION FOR INCREASING SOIL HEALTH STIPULATION

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Abstract: India harvests a large variety of food crops including vegetables, cereals, pulses, oilseeds etc. In the name of increased productivity, unselective application of vast quantity of chemical fertilizers is being encouraged which is health deathtrap. Hence, an organic method of farming is of vital need which could satisfy the increased demand of food production as well as can provide a security against any possible health problem. In present study, a single transplanted plant per pot was elevated with manual and natural irrigation in environmental condition. The result showed that the plant enactment with respect to biomass components such as number of fruits, fruits weight, fresh shoot and root weight, dry shoot and root weight, shoot length and plant height were expressively influenced by used bio-organic formulations. The total plant biomass was found to be higher with application of Dasha Parni Extract (DPE, 45 ml/plant), Leaf Extract of *Azadirachta indica* (LEAI, 50ml/plant) and *Azadirachta Capsicum Alliums* Extract (ACAE, 55 ml/plant) as compared to combination of aforesaid bio-organic formulations. Similar trend was noticed with respect to fruit weight and plant height which were found to be significantly higher 83gm and 50cm respectively when plant treated with 55ml/plant dosage, 65gm and 35cm respectively with 50 ml/plant dosage and 91gm and 43cm respectively when treated with 45 ml/plant dosage. Thus, based on this study, it may be concluded that method used for the production of tomato with the help of Bio-organic formulations (BOFs) as organic supplements, when implemented, can be effective, economical and eco-friendly method for production of various agriculture crops by farmers.

Keywords: *Bos indicus*, Bio-organic Formulations, Tomato, Soil health stipulation

INTRODUCTION

Organic standards include a well-defined set of practices and a list of technical tools that are permitted by regulations (*i.e.*, Reg no.889/08 in UE and the National Organic Program in U.S). A diet based on organic products claims to provide health benefits due to the higher concentration of nutritional compounds compared to conventional ones, and the absence of pesticide residues (Oates *L.et al.*, 2014). The present challenge of feeding the world requires new strategies to ensure food security, which is surely based on food availability and access, but also on food safety and nutritional quality. Organic production systems may be a way to ensure the sustainability of production, allowing preservation of natural resources for present and future generations, while providing a high quality and long shelf life of the product (Rembiałkowska, 2007). Agriculture plays a vital role in developing country like India. Apart from fulfilling the food requirement of the growing Indian population, it also plays a role in improving economy of the country.

Bio-organic farming is a technique to grow crops without using chemical pesticides, fertilizers, genetically modified organisms, antibiotics and growth hormones. The concept we know today as 'bio-organic farming' is a mixture of different designed biological formulations embedded mainly in the "organic agriculture speaking economies". The attentiveness of bio-organic farming in developing countries is rising because it requires less chemical

inputs and places more faith on natural and human resource available. In India, this idea is revolutionized in early 21st century, particularly in era when knowledge of agriculture sciences improved along with incorporation of farming systems of the west. Success stories of Bio-organic farming on small land holdings, especially under rain fed zones; tribal areas and North West to North East Himalaya are promoting organic farming in India.

The Green Revolution technology acceptance "between" 1960 to 2000 has increased wide varieties of agricultural crop yield per hectare which increased 12-13% food supply in developing countries. According to recent study, a 10% point's increase in the use of high-yielding crop varieties in developing countries in the period 1960-2000 led to increases in GDP per capita of approximately 15% (Gollin Douglas, *et al.*, 2018). Southeast Asia and India were the first developing countries to show the impact of GR on varieties of rice yields (Biopesticides and Biofertilizers, 2000). Use of Biopesticides and Biofertilizers can play a major role in dealing with these challenges in a sustainable way (Suman Gupta., 2010). The global population will grow to 10.12 billion by 2100 (UN, 2010/ 2011). In order to fulfill the food demand of growing population; higher and advance productive agricultural materials are required (UN, 2010/ 2011). Globally more than 125 species of natural enemies are commercially available for biological control programs such as *Trichogramma* sp., *Encarsia Formosa* str. *gahan*, and

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Phytoseiulus persimilis Athias-Henriot (Birch A.N.E., 2011).

The use of domestic bio-pesticides in the farming practices is old aged practices. It is highly eco-friendly and can obtain from nature directly. It is almost free of cost and there is no adverse impact on human health, soil, animals, plants and environment. Bio-pesticides are consequential from natural materials such as animals, plants, bacteria, and minerals. Bio-pesticides tend to be less toxic, more quickly biodegradable, and more targeted to the specific pest (US Environmental Protection Agency., 2008).

There are number of challenges faced by the agricultural sector at policy, commercial and infrastructural level. Some of the major problems and constraints for organic farming in India includes lack of awareness, output marketing problems, shortage of bio-mass, inadequate supporting infrastructure, high input costs, marketing problems of organic inputs, low yields etc. In order to address the aforesaid challenges in a better way, Jaivik Krishi (JK) package can be developed by using the combination of bio-formulations, which may help common Indian farmers in different parts of the country to produce sustainable organic agricultural crop.

Interest in organic agriculture methods is growing, especially in areas where the present farming system has degraded resources essential to agricultural production (especially land). Non-production factors, such as the farmer's health, are also mentioned as a reason for shifting to organic management. Consumers also have an interest in organic agriculture. Consumer awareness of the environmental costs of agriculture (such as the deteriorating quality of drinking water and soil, and the impact of agriculture on landscape and wildlife) is increasing. The awareness of environmental quality and health is often promoted by environmental groups, especially in developed countries. The resulting demand for organic products creates the opportunity to sell organic products at premium prices, enabling organic farmers to continue, and often expand.

Products from Cow (*Bos indicus*) particularly those with hump (Indigenous breed) is one of the key component in agriculture from ancient period, hence provision of utilizing products from at least "one cow per hectare" need to be promoted for Jaivik Krishi activities in organic farming. Suggestive evidence indicates that bio-organic food intake may reduce the risk of allergic disease and of overweight and obesity, but residual confounding is likely, as consumers of bio-organic food tend to have healthier lifestyles.

The cow's urine (*Gau-mutra*) has been described as a liquid with innumerable therapeutic values, capable of curing several incurable diseases in human beings and plants. Cow urine is rich source of macro,

micronutrients and has disinfectant and prophylactic properties. Indigenous cow milk possesses less cholesterol and high protein having high biological and nutritional value. It is easily digestible and extensively used in *Ayurvedic* medicines for treatment of various ailments. Milk from indigenous breed of cow is known to have better therapeutic values (R.K. Pathak and R. A. Ram, 2005). An important produce from Cow is *ghee* which acts as carrier agent for subtle energies. When cow ghee is burned with rice it produces oxygen, Etholine oxide, propylene oxide, and Formaldehyde, which brings immunity against bacteria, Propylene oxide induces rain. Another product, *cow dung cake* has been found to be rich in actinomycetes and was used as medicine in ancient cultures of India, South Asia, North and South America, Scandinavia and eastern and western parts of Europe (A.D.K. Dittrich and A.J. Helden, 2012).

Various BOFs have been produced by mixing cow products as described in earlier studies (K. V. Raghavendra *et.al.*, 2014). In general, cow products are mixed together in defined ratio and kept in mud pot for few days. This study is focused on the antimicrobial activities of dung extracts of Indian and imported cows against plant pathogens and their importance as plant growth promoting bio-organic formulations, using tomato as model crop. The increasing concern for environmental safety and global demand for pesticide residue free food has induced extreme interest in crop production using eco-friendly products which are easily biodegradable and do not leave any harmful toxic residues besides conserving nature. So it is necessary to use natural products like bio-organic formulation to produce chemical residue free food crops and hence bio-organic formulation can play a major role in organic farming.

MATERIALS AND METHODS

Organic Farming is a farming method which aims at cultivating the land and raising crops in such a way that the soil is kept alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials. It aims to produce crop with a high nutritional value.

A. Procurement of seed: The seed of tomato were obtained from Muzaffarnagar seed market (India). Tomato (*Solanum lycopersicum*) is one of the most important vegetable plants in the world. It originated in western South America, and domestication is thought to have occurred in Central America. Tomato has been widely used not only as food, but also as research material.

B. Formulating BOFs: Take water in a large container then added all types of leaves. Turn on the stove and keep a large vessel on it pouring all the cow urine in it. After ten minutes, put the mixture of blended leaves in the vessel and stir. Add water to

make the mixture of total 4 liters. Boil the mixture for one hour from now. After turning off the stove, let the mixture cool down. Now take a cotton cloth preferable of white color and filter down all the mixture from it. Store the solution in a drum. For a liquid foliar spray apply 3% to 10% in water, and for soil, use 100-200. It's used per acre during irrigation. Taking this formulation as Base solution, three BOFs are made as follows:

1. DPE (Dasha Parni Extract): 'Dasparni' word comprises of two different words 'Dasha' means Ten and 'Parna' means leaf of plant or tree. This plant

growth promoting formulation was made by mixing Base solution with leaf extract from 10 important medicinal plants as shown in Table 1.

2. ACAE (Azadirachta Capsicum Alliums Extract): ACAE, also a plant growth promoting BOF, is formulated by mixing Base solution with extracts of chilli, garlic and tobacco (Table 2).

3. LEAI (Leaf Extract of Azadirachta indica): This bio-pesticide BOF was formulated by adding Neem extract to the base solution to check activity of sucking pests and Mealy Bug. Its formulation is shown in table 3.

Table 1. Materials used preparation of DPE

Materials	g/l	Materials	g/l
Castor plant leaves	20gm	Hing	0.1gm
Neem tree leaves	20gm	Ginger	4.0gm
Guava tree leaves	20gm	Turmeric	4.0gm
Tulsa plant leaves	20gm	Tobacco	10gm
Indian Bail plant leaves	20gm	Chili	10gm
Mango tree leaves	20gm	Garlic	10gm
Pomegranate tree leaves	20gm	Cow urine	200ml
Hibiscus Rosa plant leaves	20gm	Cow dung	200gm
Mari gold plant leaves	20gm	Tap water	2litre
Yellow oleander leaves	20gm	-	-

Table 2. Materials used preparation of ACAE

Materials	g/l
Cow urine	500 ml
Tobacco powder	12.5 gm
Green Chili	12.5 gm
Garlic	6.0gm
Neem leaves	100gm

Table 3. Materials used preparation of LEAI

Materials	g/l
Water	2 liter
Cow urine	100 gm
Cow dung	20gm
Neem leaves	100 gm

C) Plant growth promotion using Bio-formulations (PGPB)

Preparation of Soil Mixture

To evaluate DPE, ACAE, LEAI application, a special soil mixture was prepared. The configuration of soil mixture contains of Coco-peat, loamy soil and cow dung (3:4:1), mixed well and filled in the experimental pots (75 × 38cm) and 12 experimental pots were arranged for treatments.

In situ experiments

1. Preparation of Nursery pots

The seeds of tomato were sown in plastic pot filled with equal amount of designed soil mixture. After twenty days, seedlings were transplanted into experimental pots.

2. Transplantation

i) Research Trial

We established small experimental trial to check the effect of different concentration of bio-organic formulations. During transplantation, seedlings were treated with different concentrations of BOFs (45ml, 50ml and 55ml, respectively for each formulation) in replicates of three. At every six day interval (till data collection after 60 days of growth), same treatment of bio-organic formulation was repeated. For further experimentation, dosage with optimal growth parameters was chosen for each BOF.

ii) Optimal dosage experimentation

Tomato plantings were transplanted as a triplicate of nine pots containing soil mixture. Each set of nine pots were further divided into set of three and each set was treated with 45 ml DPE/set, 50 ml ACAE/set and 55 ml LEAI/set, respectively at the onset of vegetative phase. Irrigation was done by common agricultural practices throughout the experiment. At

every six day interval (till data collection after 60 days of growth), same treatment of bio-organic formulation was repeated.

3. Analysis of phenotypic characters

Plant growth was measured after 60 days taking into account phenotypic characters such as plant height (PH), plant weight (PW), shoot length (SL), shoot weight dry (SD) and fresh (SF), root length (RL), root weight dry (RD) and fresh (RF), number of leaves (NL), number of fruit (NF) and fruit weight (FW). These phenotypic characters were observed and recorded from 15th-60th day. After 60 days final measurement of phenotypic characters was documented. Further, the dry weight was obtained after oven drying at 65^oC for 48 hours using two plant samples from each treated replicate.

RESULT

Table 1. Differential Effect of BOFs on Biomass of Tomato Plant.

Treatment groups	Fresh Biomass	Total SF & RF (gm)	% Increase in fresh biomass	Total SD& RD (gm)	% Increase in dry biomass
Control	160.45	150.2	0.00	21.74	0.00
DPE -45 ml	233.09	206.53	1.45	39.21	1.81
ACAE -50 ml	195.21	180.05	1.22	32.48	1.49
LEAI -55 ml	174.35	157.74	0.20	22.75	1.04

Overall, the growth was found to be higher in treated cases as compared to control. Plants treated with DPE, ACAE and LEAI showed significant difference in shoot length, leaf count, root length and weight of the tomato plants (Fig. 2). All phenotypic attributes responded positively on application of various BOFs. Tomato growth parameters such as plant height (PH), plant weight (PW), shoot length (SL), shoot weight dry (SD) and fresh (SF), root length (RL), root

weight dry (RD) and fresh (RF), number of leaves (NL), number of fruit (NF) and fruit weight (FW) were significantly increased under the influence of DPA, ACAE and LEAI application (Fig-1). Data is summarized in Table 2. It is evident from Table 2, fig. 1 and fig. 2 that application of DPE has the maximum effect on overall growth, followed by ACAE and then LEAI.

Table 2. Effect of various dosage of bio-organic formulation on Biomass of Tomato.

SET	NL	NF	FW (gm)	SF (gm)	RF (gm)	SD (gm)	RD (gm)	RL (cm)	SL (cm)	PH (cm)
Control	102.38	05	10	090.26	62.41	11.23	06.07	102.24	41.61	24.57
DPE (45ml)	165.61	15	91	152.11	59.67	23.26	11.45	122.40	56.61	43.00
ACAE (50ml)	145.25	11	65	132.60	44.58	20.67	05.76	76.00	47.00	35.00
LEAI (55ml)	160.92	20	83	102.53	52.07	14.43	04.58	134.34	46.23	50.00

The following values are tabulated by taking mean of replicates on optimal BOF concentration i.e. DPE (45ml), ACAE (50ml) and LEAI (55ml). Abbreviated words are as plant height (PH), plant

weight (PW), shoot length (SL), shoot weight dry (SD) and fresh (SF), root length (RL), root weight dry (RD) and fresh (RF), number of leaves (NL), number of fruit (NF) and fruit weight (FW).

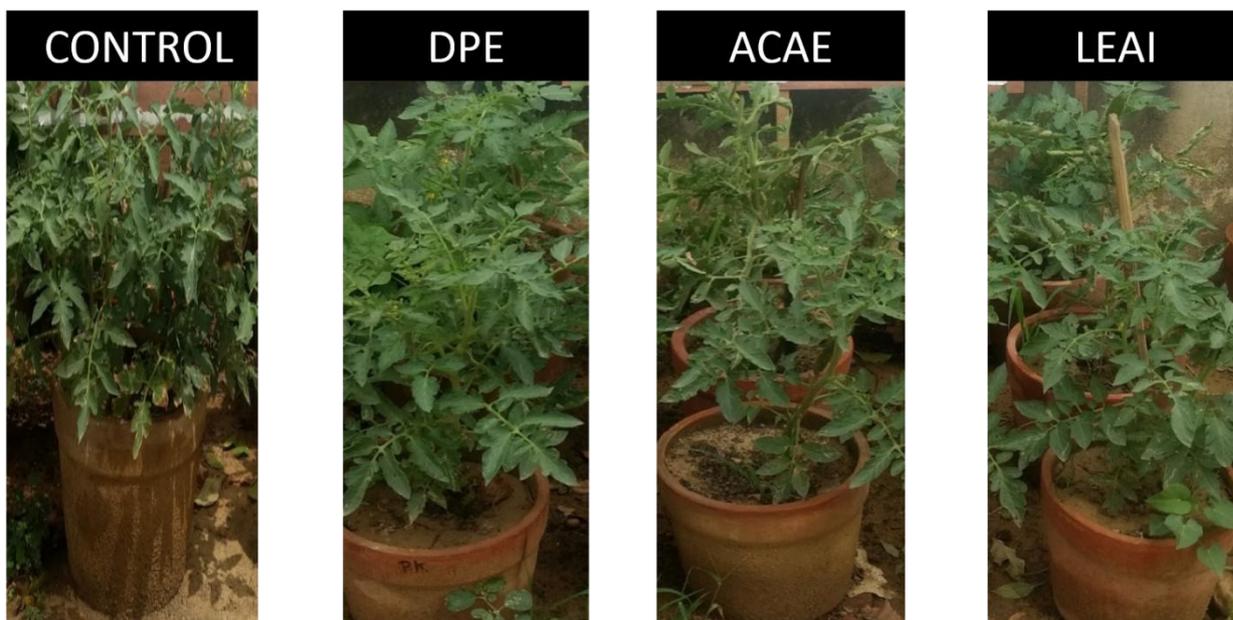


Fig 1. Effect of various dosage of bio-organic formulation on Biomass of Tomato.

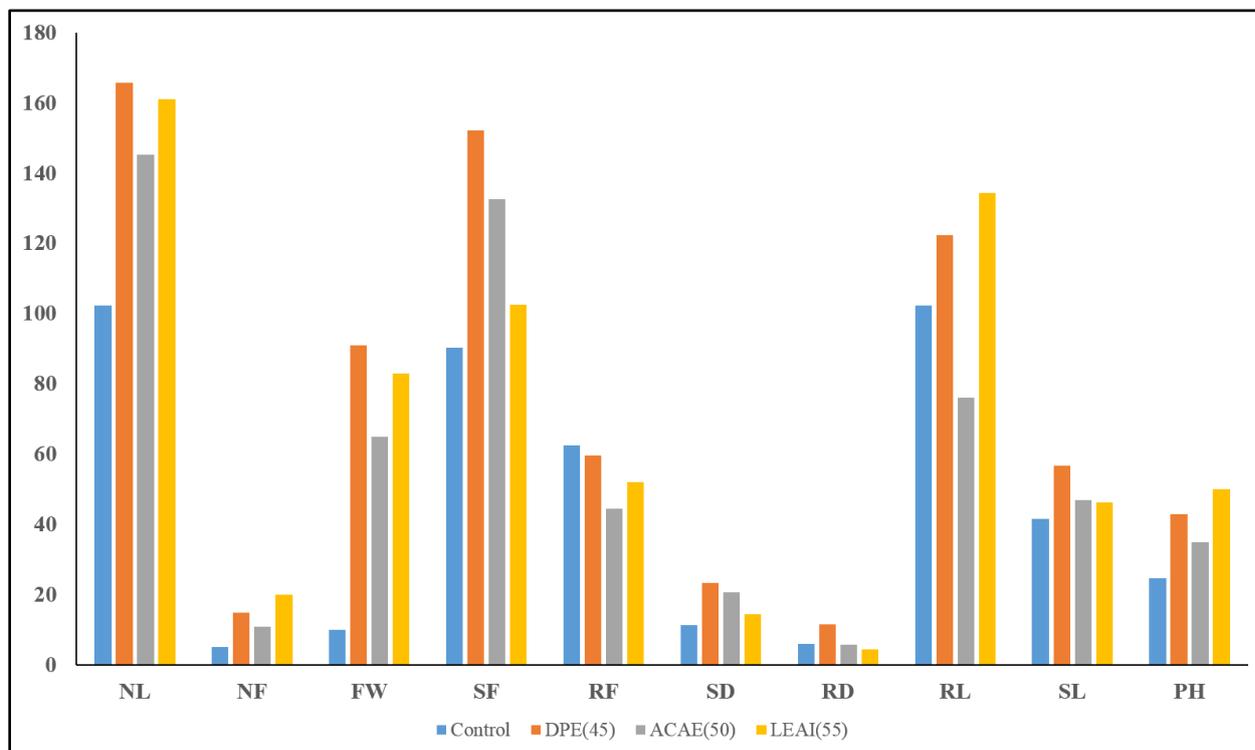


Fig 2. Reproductive growth in Tomato (control vs Treated) after 60 days of sowing.

Further, to depict the accuracy and significance of data, observations were statistically tested using independent t-test on mean values of different phenotypic characters.

Table 3. Independent t-test on various dosages of BOFs on Biomass of Tomato to calculate the significance level of observations.

Biomass Parameter	Control	DPE DOSE 45ml/plant		ACAE DOSE 50 ml/plant		LEAI DOSE 55 ml/ plant	
	Mean	Mean	p-value	Mean	p-value	Mean	p-value
NL	102.3	165.6	0.00**	145.2	0.03*	160.9	0.007*
NF	5.00	15.00	0.005*	11.00	0.00*	20.00	0.187
FW(gm)	10.00	91.00	0.001**	65.00	0.023*	83.00	0.263
SF(gm)	90.260	152.11	0.002**	132.605	0.072	102.532	0.288

RF(gm)	62.41	59.67	0.001**	44.58	0.787	52.07	0.332
SD(gm)	11.23	23.26	0.003**	20.67	0.050*	14.43	0.320
RD(gm)	6.07	11.45	0.002**	5.76	0.398	4.58	0.356
RL(cm)	102.24	122.4	0.113	76.00	0.127	134.34	0.576
SL(cm)	41.61	56.61	0.032*	47.00	0.697	46.23	0.521
PL(cm)	24.57	43.00	0.044*	35.00	0.648	50.00	0.325

Test applied: Independent t test (Testing of means),*Statistically Significant at 5% level of Significance ($p < 0.05$) **Highly Significant at 5% level of Significance ($p < 0.005$).

DISCUSSION

Due to the reported potential performance of BOFs on several crops and, DPE, ACAE and LEAI in *Solanum lycopersicum* plant, the present study was carried out in an attempt to elucidate its effect on vegetative and reproductive growth of pot cultured tomato plant. BOFs showed significant and consistent improvement in vegetative growth and also significantly increased the number of fruits and number of leaves at different intervals throughout the period of experiments as compared to the control indicating its potent growth stimulating activity. These evidences tempt us to speculate that apart from the aforementioned probable DPE action, the other possible mechanism i.e. development of disease resistant in tomato might be contributed to free microbial metabolites of BOFs solution.

The result is in accordance with the previous results conducted with BOFs and extract of leaves further suggesting that the available form of active principles in BOFs and higher arriving water in plant system (45 ml / plant) might be contributing in the regulation of plant growth. Taken together, it can be summarized as BOFs might possess both vegetative and reproductive stimulation mechanisms in it actions and such apparent dual action of BOFs would be more advantageous to the other existing commercial organic inputs.

It is well recognized that the foliar application of fresh Drumstick leaf and twigs juice along with *Panchagavya*, Humic acid, and de oiled seed cake can positively influence the plant biomass parameters (Prabhu, 2010; Balakumbahan and Rajamani, 2010; Emmanuel 2011a & b). It has been reported that 30 times diluted *Moringa* leaf extract significantly increased seed and seedling vigour in wheat (Afzal *et al.*, 2008), Maize (Basra *et al.*, 2011) and many grass species including *Cenchrus ciliaris*, *Panicum antidotale* and *Echinochola crusgalli* (Nouman *et al.*, 2012a). *Moringa* leaf extract spray increased the yield in crops like peanut (5319 kg/hect), onion (4194 kg /hect) and black bean (1194 kg / hect) compared to their respective control (Foidl *et al.*, 2001).

Several experiments were sustained that the increased growth and yield parameters by foliar application of *Moringa* leaf extracts at different percentage and combined with *Panchagavya* and Humic acid. The mixture of all different organic substances are economically viable for producing higher dry herbage yield in sacred basil - *Ocimum*

sanctum L., (Prabhu *et al.*, 2010). The same impacts of higher value of growth and yield were recorded in Senna crop *Cassia angustifolia* var.KKM.1 (Balakumbahan and Rajamani, 2010).

The field investigation established the fact that application of *M. oleifera* de-oils seed cake without pre-decomposition as an organic fertilizer on a maize farm achieved significant improvement on soil nutrient as well as the plant yield, as compared to the control (Emmanuel *et al.*, 2011a & b). *Moringa* leaf extract (MLE) is a plant growth enhancer that improves seedling emergence of rangeland grasses, seedling vigor and growth as compared to other seed priming techniques (Nouman *et al.*, 2012 a & b). Wheat (*Triticum aestivum*) seeds priming with *Moringa oleifera* leaf extract had induced the antioxidative system together with increased chlorophyll contents, ascorbic acid and soluble phenolics contents (Yesmeen *et al.*, 2013).

Remaining to the reported potential performance of *Jeevamrit* on tomato plants (Rajamani *et al.*, 2014), the present study was carried out in an attempt to explain its effect on vegetative and reproductive growth of pot cultured tomato plant. The composition of dasparni extract was first developed and applied on tomato and papaya at AL Khaly farm in UAE to withstand temperature and well crop was observed (Vijayan Pillai, 2012). It has been reported that 30 times diluted Sahjanleaf extract significantly increased seed and seedling vigour in wheat (Afzal *et al.*, 2008), Maize (Basra *et al.*, 2011) and many grass species including *Cenchrus ciliaris*, *Panicum antidotale* and *Echinochola crusgalli* (Nouman *et al.*, 2012a). Sahjan leaf extract spray increased the yield in crops like peanut (5319 kg/hect), onion (4194 kg /hect) and black bean (1194 kg / hect) compared to their respective control (Foidl *et al.*, 2001).

Several experiments were sustained that the increased growth and yield parameters by related to leaves application of Sahjanleaf extracts at different percentage and combined with *Jeevamrit*. The mixtures of all different organic substances are economically viable for producing higher dry herbage yield in sacred basil (Prabhu *et al.*, 2010). The same impacts of higher value of growth and yield were recorded in Senna crop *Cassia angustifolia* var.KKM.1 (Balakumbahan and Rajamani, 2010). The field investigation established the fact that application of *M. oleifera* de-oils seed cake without pre-decomposition as an organic fertilizer on a maize farm achieved significant

improvement on soil nutrient as well as the plant yield, as compared to the control (Emmanuel *et al.*, 2011a & b). *Moringa* leaf extract (MLE) is a plant growth enhancer that improves seedling emergence of rangeland grasses, seedling vigor and growth as compared to other seed priming techniques (Nouman *et al.*, 2012 a & b).

Triticum aestivum seeds priming with Sahjan leaf extract had induced the antioxidative system together with increased chlorophyll contents, ascorbic acid and soluble phenolics contents (Yesmeen *et al.*, 2013). The leafy spray of aqueous extracts of 2% of leaf and 3% of twig of *Moringa oleifera* on Rocket plants (*Eruca vesicaria*) potentially increased all measured growth criteria of Biomass and physiological activities like photosynthetic rates, stomatal conductance, the Bio-molecules of chlorophyll a and b, carotenoids, total sugar, total protein, phenols, ascorbic acid, N, P, K, Ca, Mg, Fe as well as growth promoting hormones-Auxins, gibberellins and cytokinins. The extracts at all concentrations applied, negatively reduced the level of lipid peroxidation and the activities of antioxidant enzymes (Catalase, peroxidase, superoxide, dismutase). Thus it is concluded that Sahjanleaf and twig extracts can be used as bio-organic fertilizer for various crops due to its high productivity, high nutritive value, antioxidant effect, and easy preparation, low cost and environmental friendly nature. (Mona M. Abdalla, 2013).

In our previous study we showed the empirical evidence that the treatment of bio-organic formulations caused significant as well as moderate improvement on biomass level of *Brassica oleracea* .L, (Rajamani *et al.*, 2014) further sustaining its potential in tomato. Since DFLJ effectively improves the root surface area, it causes early flowering in tomato. The significant growth perhaps might include the establishment of favorable microclimate niche around the rhizosphere for consortium and *Jeevamrit* microbial community to enhance feeding root growth.

These confirmations attract us to risk that apart from the above-mentioned probable bio-organic formulations action, the other possible mechanism i.e. development of disease resistant in tomato might be contributed to free microbial metabolites of *Jeevamrit* solution and beneficial inoculum of consortium.

CONCLUSION

From the above enumeration, it can be concluded that bio enhancers could be a potent source to improve soil fertility, crop productivity and quality. This can also be a potential alternative for fertigation which is becoming common in most of the crops. However, care should be taken that bio enhancers which are used in limited quantities cannot meet the entire nutrient requirement of the crops. These

simply catalyze quick decomposition of organic wastes in to humus, hence incorporation of enough bio mass preferably combination of monocot and legumes duly supplemented with animal wastes will be helpful in quality production of humus, which is prerequisite for improving soil fertility and crop productivity. Combined with manures and frequent use of bio enhancers can address many challenges of agriculture and will be surface way for sustainable agriculture through organic resources. It acts as manure for soil and plants. ACAE was best pest control comparison to other chemical pest control. LEAI to control sucking pests and Mealy Bug. This process was strongly dependent on the environmental condition.

Bio-organic formulation ACAE is increasing level from other formulation DPE, LEAI. Mean number of leaves is better in high concentration of DPE (165.6) other formulations ACAE, and LEAI. Number of fruits output is better for ACAE (20) than other formulations DPE and LEAI. Fruits weight is also increasing by applying DPE (91) other formulations ACAE and LEAI. Fresh shoot weight is also increasing by applying DPE (152.115) other formulations ACAE and LEAI. Dry shoot weight is output better for DPE (23.2657) than other formulations ACAE and LEAI. Shoot length is also better for DPE (56.61) other formulations of ACAE and LEAI Plant height is better for ACAE (50.00) other formulations ACAE and LEAI.

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