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Assessment of *Moringa oleifera* Lam. leaf extract as natural biostimulant on tomato (*Lycopersicon esculentum* Mill.) crop production

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ABSTRACT

The present study aims to assess the effect of aqueous and low concentrated aqueous-ethanolic *Moringa oleifera* leaves extract (MOLE) as natural biostimulant on the productivity and yield of tomato (*Lycopersicon esculentum* Mill.). MOLE was prepared from fresh leaves (500 g in 500 ml distilled water) and designated as 100 per cent. From this, 12.5 per cent MOLE was taken common to all treatments except control whereas 10, 20 and 30 per cent aqueous ethanol was used to dilute. Five different treatments *viz.*, T1-control, distilled water spray only, T2-12.5 per cent MOLE in distilled water, T3-12.5 per cent MOLE in 10 per cent aqueous ethanol, T4-12.5 per cent MOLE in 20 per cent aqueous ethanol and T5-12.5 per cent MOLE in 30 per cent aqueous ethanol were employed as foliar application mixed with surfactant for proper adherence, once a week starting from flower bud initiation till most of the fruits matured for harvesting. Increase in tomato yield *i.e.* fresh weight was 163.98 per cent and dry weight 167.85 per cent as compared to control was recorded with 12.5 per cent MOLE in 20 per cent ethanol (T4). The study indicates that *Moringa oleifera* leaf extract can be successfully used in vegetable production to improve productivity and yield in an environmentally friendly manner reducing fertilizer and pesticide consumption.

Key Words:

Biostimulant, crop productivity, eco-friendly, foliar spray

INTRODUCTION

In last decades, attentions have been paid to reduce the frequent use of inorganic fertilizers with their lethal effects which forced the people to adopt the natural organic farming despite of its high cost (Winter and Davis 2006). However, the cost in organic farming may be minimized through application of natural

biostimulants/boosters obtained from natural sources such as seaweed and botanical extract enhancing crop yield to a great extent. These natural biostimulant enhance seed germination, growth and yield of vegetable crops apart from being inexpensive compared to synthetic growth promoters *viz*. zeatin, kinetin available in the market (Kannaiyan 2000).

India is the second largest producer of vegetables in the world next to China accounting for 14 per cent of world production of vegetables (Khnut et al. 2006). However, India needs to accelerate its vegetable production, considering the ever increasing demand for vegetables and to overcome the problem of socio-economic inequity. Vigneshwara (2001) showed that the demand of vegetables by 2030 will be about 250 million tons and to accomplish this exceptional demand, the vegetable production and marketing have to be improved. Tomato (*Lycopersicon esculantum*) is a high value vegetable crop enriched with 'A' and 'C' vitamins which benefits farmers extensively. It is used not only in most households but it's by products like sauce, *chutnies*, ketch-up *etc*. have vast commercial market. According to APEDA report 2016-17, position of India for tomato (chilled/fresh) export in global market is 52 (agriexchange.apeda.gov.in). Among Indian states, Jharkhand placed at 16 positions for tomato production with 230.19 tons production and having 1.23 per cent share (National Horticulture Board, 2015-16 data). As a result its demand is high; consequently necessitating studies to enhance the productivity on available land resources to benefit the cultivators. Further, it has been found that tomato cultivation is highly dependent on mineral nutrition (FAO 2003).

Moringa oleifera Lam. is one of the best known and most widely distributed and naturalized species of a monogeneric family Moringaceae (Ramachandran et al. 1980). Native to India and red sea part of South Africa including Madagascar (Price, 1985), the popularity of this tree is due to its high nutritional leaves, pods and flowers (Fugile 2005). *M. oleifera* leaves contains high amount of cytokinins, free amino acids, minerals *etc*. in their aqueous or ethanolic extract enhances the crop yield upto 20-25 per cent (Fuglie 2001, Chang et al. 2007; Mishra et al. 2013). *Moringa* leaves extract as natural biostimulants has been proved to be especially effective on vegetables crops (Balbir 2006). *Moringa* is a common tree planted in households by the farmers in most parts of India. Thus, farmers will be able to embrace this simple intervention and utilize the available resource with little or no cost (Makkar and Becker 1996). Thus the present study was carried out to access the effect of aqueous and different ethanolic extract of *M. oleifera* leaves on the productivity and yield of tomato, popular vegetable crop suitable and preferred by local famers in the Eastern India.

MATERIALS AND METHODS

Experimental area

A field experiment was conducted at Ranchi in Eastern India (23°21'26"N, 84°14'44"E) during December 2012 - March 2013. Loamy soil of the area had pH in the range of 5.5 to 6.5. Certified tomato seeds of uniform size and colour were used for production of good seedlings and then transplanted the seedlings at a spacing of 30 x 30 cm in 3.66 x 1.22 m size beds.

Preparation of Moringa Leaf Extract

MOLE was prepared according to Price (2007) and Goldberg (2008). In brief, MOLE was prepared from fresh leaves 500g in 500 ml water and designated it as 100 per cent. From this 12.5 per cent MOLE was taken common to all treatments except control whereas 10, 20 and 30 per cent aqueous ethanol was used to dilute it or simply distilled water was taken to get 12.5 per cent. Five different treatments *viz*., T1-control, distilled water spray only, T2-12.5 per cent MOLE in distilled water, T3-12.5 per cent MOLE in 10 per cent aqueous Ethanol, T4-12.5 per cent MOLE in 20 per cent aqueous Ethanol and T5-12.5 per cent MOLE in 30 per cent aqueous ethanol were employed as foliar application mixed with surfactant for proper adherence, once a

week starting from flower bud initiation till most of the fruits matured for harvesting. Experiment was laid out in a randomized block design with four replications per treatment.

Four harvestings of ripe fruits were taken at weekly interval to record fresh and dry weight of harvested tomato fruits. The data obtained were subjected to statistical analysis, employing analysis of variance (ANOVA), 'F'-test for significance at $P \leq 0.05$ and computing LSD values to separate means in different statistical groups using statistical software IBM SPSS version 18.

RESULTS AND DISCUSSIONS

Improvements in crop growth and yield due to MOLE foliar spray occur primarily due to the influence of zeatin (Price 1985; Fuglie 2000; Yasmeen et al. 2011). Zeatin is the most naturally occurring cytokinin that not only promotes the growth of plants by facilitating cell division, cell elongation, leaf senescence, apical dominance, lateral root formation, stress tolerance, and nutritional signaling but also has anti-aging potential and protective effects in plants (Amin, 2003; Werner et al. 2003; Marcu, 2005; Taiz and Zeiger, 2006; Sakakibara, 2006; Argueso et al. 2009). Endogenous levels of cytokinins have also been linked with fruit growth (Gillaspy et al. 1993; Hayata et al. 1995; Hayata et al. 2000; Flaishman et al. 2001, Stern et al. 2003; Srivastava and Handa 2005; Kim et al. 2006; Zabadal and Bukovac 2006). *Moringa* leaves gathered from various parts of the world were found to have high zeatin (a type of cytokinin) concentrations of between 5 mcg and 200 mcg/g of leaves (El Awady, 2003). It is also established that biostimulant effect of MOLE are not only due to cytokinin like hormones but it is synergetic effect of all biochemical and minerals present in leaves which acts simultaneously to improve the soil and crop productivity (Fig.1) (Yakhin et al. 2017).

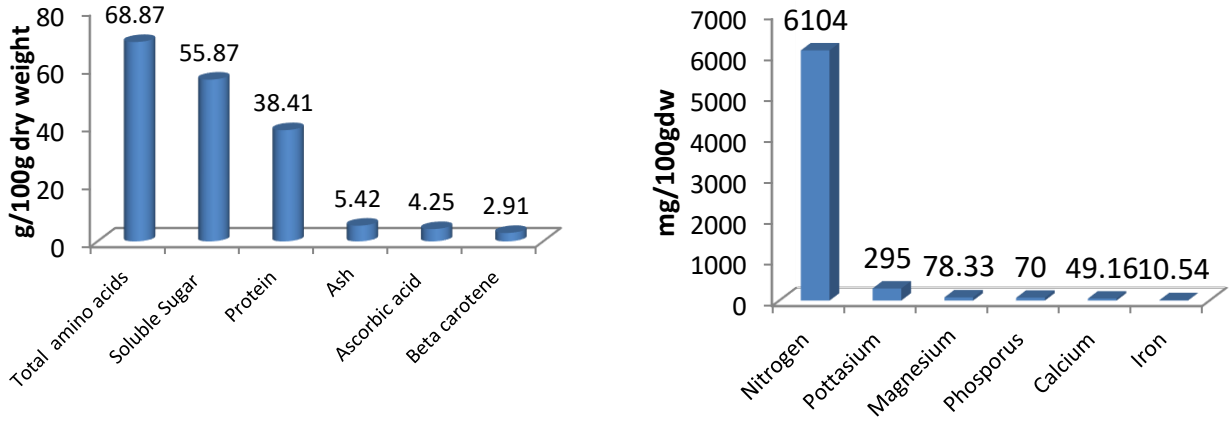

Fig.1 Biochemical and mineral content in *Moringa oleifera* leaves

Significant enhancement of the fresh and dry weight of tomato was recorded with 12.5 per cent MOLE in 20 per cent ethanol (T4) (Table 1). There was no difference in the yield of tomatoes in response to application of 12.5 per cent MOLE in water (T2), 12.5 per cent MOLE in 10 per cent ethanol (T3) and 12.5 per cent MOLE in 30 per cent ethanol (T5) in fresh and dry weight. The 12.5 per cent MOLE in 20 per cent ethanol (T4) treatment recorded a significant increase in tomato yield *i.e.* fresh weight 163.98 per cent and dry weight 167.85 per cent as compared to control (Fig. 2 and Fig. 3). A comparison of estimated yield in tons per ha exhibits substantial benefits from application of this treatment (Fig. 4).

Table 1: Effect of *Moringa oleifera* leaf extract (MOLE) on yield of tomato fruits

Treatments	Fresh weight of Tomato (Kg)	Dry weight of Tomato (Kg)
Control (T1)	1.28	0.112
12.5per cent in distilled water (T2)	1.40	0.114
12.5 per cent in 10per cent aqueous ethanol (T3)	1.66	0.145
12.5per cent in 20per cent aqueous ethanol (T4)	3.38	0.300
12.5per cent in 30per cent aqueous ethanol (T5)	1.56	0.125
$LSD_{0.05}$	1.30	0.14

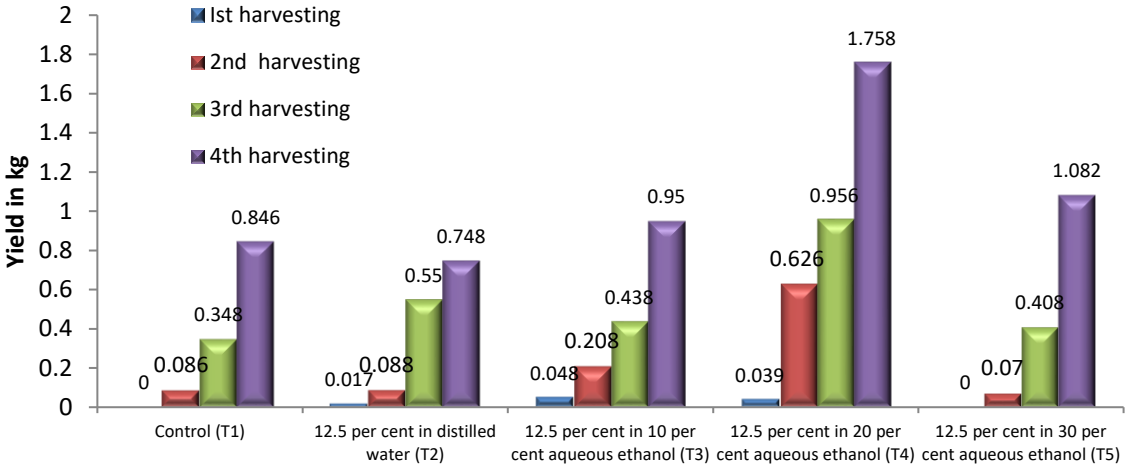

Fig. 2: Yield of Tomato at different time of harvesting in MOLE treated and untreated tomato plants

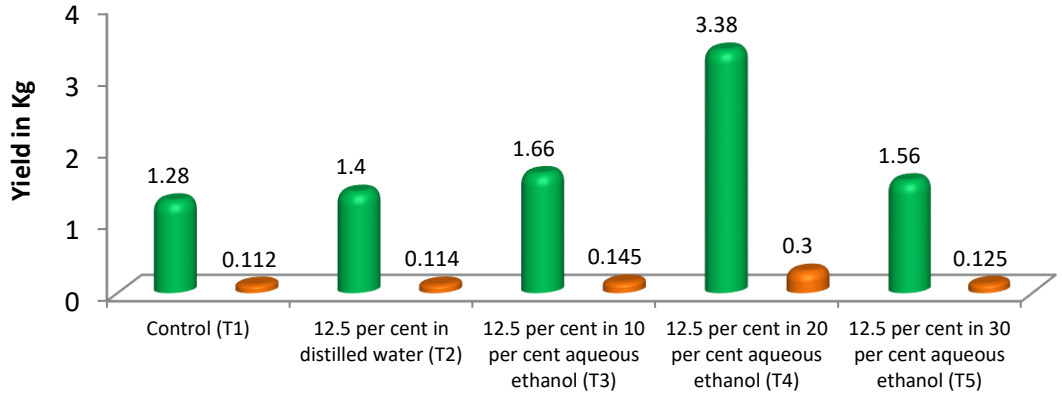

Fig. 3: Total fresh and dry weight of Tomatoes of MOLE treated and untreated tomato plants

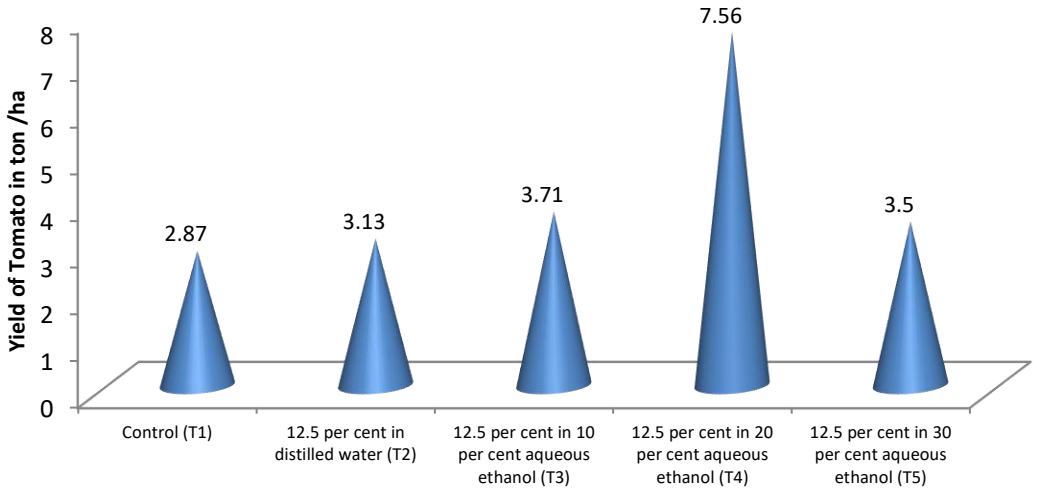

Fig. 4: Comparison of estimated yield of tomato ha^{-1} with different levels of MOLE treatment

MOLE spray affects the crops by longer life-span, heavier roots, stems and leaves, produce more fruit, larger fruit and increase in yield 20-35per cent (Foidle et al. 2001,), highlighting its opportunity of use as a foliar spray to accelerate growth of young plants in minimal investment well within the reach of poor and marginal farmers. In our previous study on pea, we have found that 12.5per cent aqueous leaf extract increases the pea yield up to 51per cent (Mishra et al. 2013). Culver et al. (2012) have reported that MOLE (80 per cent ethanolic extracted) increases tomato fresh weight upto 141per cent in comparison to control.

Further, higher yield in the 12.5 per cent MOLE in 20 per cent ethanol may be due to the better solubility of the MOLE in 20 per cent ethanol while MOLE in 10 per cent and 30 per cent ethanol gave almost same yield of tomato. Cytokinin like substances *viz.* Zeatin and other biochemical content may be more soluble in moderate low concentration of alcohol with water (Fuglie 2000). Since water is easily available so that we used very small concentration of polar organic solvents to see the effect of these ratios on the growth of plants. It has been observed that higher or lower concentration of aqueous ethanol reduced the yield of tomato in comparison to the 20 per cent ethanol (Table 1). A significant enhancement in tomato yield i.e. fresh weight 163.98 per cent and dry weight 167.85 per cent as compared to control was recorded with 12.5 per cent MLE in 20 per cent ethanol. These findings are in confirming with the previously used natural biostimulant on tomato crop *i.e.*141 per cent yield was recorded using MOLE while 89 per cent yield with 5 per cent aqueous extract of seaweed *K. alvarezi* (Zodape et al. 2011; Culver et al. 2012). However, Kaushal et al. 2011 had reported alloleopatic effects of trees on agriculture crops.

Successive applications of MOLE have been resulted in consistently enhanced fruit yield as evident in results obtained in four harvestings (Fig.2), possibly due to better plant growth, biomass accumulation and efficient resources allocation due to beneficial constituents and their synergetic impact on the plants. Thus, MOLE can be successfully used in vegetable production to improve productivity and yield in an eco-friendly manner reducing fertilizer and pesticide consumption. However, optimization of doses will be crucial as exogenous application of cytokinins in high concentrations results in growth inhibition especially that of the lateral roots (Srivastava 2002; Skylar et al. 2010). Higher concentrations of MOLE is found to

have decrease fruit yield or have negative effect on the growth of plants (Mishra et al. 2013). Overall, a fine adjustment of cytokinin levels within the plant is needed to achieve the optimal growth of shoots (Rupp et al. 1999; Gan and Amasino. 1995). It was also observed that higher doses of leaf extracts became either supra optimal or inhibitory for fruit yield and plant growth.

CONCLUSIONS

Moringa oleifera leaf extracts (MOLE) reveals their potential as natural biostimulant for better vegetable crop production in eco-friendly manner. In tomato, for enhanced fruit yield, 12.5 per cent MOLE in 20 per cent aqueous ethanol may be recommended. However, optimization of doses are crucial as higher doses of leaf extracts became either supra optimal or inhibitory for fruit yield and plant growth. This study also established our earlier work on Moringa leaf extract that MOLE is a potential eco-friendly natural biostimulant which improve productivity and yield of crops with reducing fertilizer and pesticide consumption.

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