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# Studies on effect of Biostimulants on Growth, Yield and Quality of Mango (*Mangifera indica* L.) *cv*. Imam Pasand under Ultra High Density Planting (UHDP) System

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**ABSTRACT: A field experiment was carried out in Western block, Department of Fruit Science, Horticultural College and Research Institute, TNAU, Periyakulam during 2021-22 to study the effect of different biostimulants on growth, yield and quality of mango *cv*. Imam Pasand under UHDP system. The experiment was laid in Randomized Block Design with thirteen treatments replicated thrice and each replication had three trees. The treatments comprised of Seaweed extract (0.1%, 0.2%, 0.3%); Panchagavya (1%, 2%, 3%) and Fulvic acid (1%, 2%, 3%) [applied in soil through drip laterals] and Vermiwash (1%, 2%, 3%) [applied as foliar spray] and control. The treatments were applied twice, first at pre flowering stage and second after fruit set (pea or marvel stage) in mango trees. The results obtained clearly showed that, the biostimulants had a significant effect on mango trees. Among the treatments imposed, 3% vermiwash recorded maximum plant height; increased leaf area, total chlorophyll content and nutrient content (N, P, K) in the leaves, and also recorded maximum yield per tree and higher fruit quality such as TSS, titratable acidity and total sugars compared to other treatments and control.**

**Keywords***:* Mango, Biostimulants, Seaweed extract; Panchagavya, Fulvic acid, Vermiwash.

## INTRODUCTION

India is owed with varied climatic conditions, which favours cultivation of a wide range of fruit crops from tropical, subtropical and temperate zones to arid and semiarid regions. One of the important fruit crops in which India is leading in production is Mango, a tropical crop but can be grown in subtropical regions (Parthiban *et al.,* 2020). Mango belongs to the family Anacardiaceae and originated in South-East Asia. It is an evergreen tropical fruit tree, delicious and it is a choice fruit in India. It is known to be "The King of Fruits" due to its delicious taste, flavour, attractive colour, nutritive value and superior fragrance (Kumar *et al.,* 2021).

India produces about 50% of World Mango production, having the largest area under production (Parthiban *et al.,* 2020). Recently, due to changing climate and undesirable biotic and abiotic stresses the quantity and quality of Mango fruits are getting degraded. To prevent this, practice of various types of chemical fertilisers and pesticides are used, having an undesirable effect on the natural environment as well as human beings. Implementation of organic substances such as biostimulants instead of chemical fertilizers is necessary to raise and maintain soil fertility and health as well as food quality (Mosa *et al.,* 2021). Biostimulants can be defined as "natural or synthetic substances that can be applied to plants, seeds or soil which can cause changes in vital physiological or structural processes to enhance the growth of plants by improving their abiotic stress resistance and enhancing fruit yield and quality" (Jatin *et al*., 2020). These are non-fertilizer products that have beneficial effects on plant growth and do not contain any chemicals or synthetic substances.

Keeping the above points into account, a study was under taken with an objective to study the effect of biostimulants on growth, yield and quality of mango *cv*. Imam Pasand under UHDP system.

## MATERIALS AND METHODS

The experiment was conducted at Field No. 5, Western block, Department of Fruit Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam, Theni, Tamil Nadu (Latitude 10°12′N and longitude 77°59′E) during the year 2021-22. The spacing between Mango plants *cv*. Imam Pasand was 3 × 2 m. The biostimulants used were Seaweed

extract, Panchagavya, Fulvic acid and Vermiwash each with three different concentrations. The detail of the treatments imposed in this study were given in Table 1.

**Table 1.**

| Treatment No. | Biostimulants Details |
|---|---|
| $T_1$ | Seaweed Extract 0.1% |
| $T_2$ | Seaweed Extract 0.2% |
| $T_3$ | Seaweed Extract 0.3% |
| $T_4$ | Panchagavya 1% |
| $T_5$ | Panchagavya 2% |
| $T_6$ | Panchagavya 3% |
| $T_7$ | Fulvic Acid 1% |
| $T_8$ | Fulvic Acid 2% |
| $T_9$ | Fulvic Acid 3% |
| $T_{10}$ | Vermiwash 1% |
| $T_{11}$ | Vermiwash 2% |
| $T_{12}$ | Vermiwash 3% |
| $T_{13}$ | Control (No Biostimulants) |

The biostimulants seaweed extract, panchagavya and fulvic acid were applied through drip laterals as soil application and vermiwash was applied as foliar spray. The treatments were applied to the trees twice *viz*., first at the pre flowering stage and second after fruit set (at pea or marvel stage).The treatments were replicated thrice in Randomised Block Design (RBD). A total of one hundred and seventeen trees of same height, vigour and disease free with drip irrigation were selected for the experiment (three trees for each treatment). All the selected trees were provided with uniform horticultural practices *viz*., fertigation, irrigation, pruning etc. were followed during the experimentation period.

The growth parameters such as plant height, leaf area, total chlorophyll content of the leaves and leaf nutrient content (N, P, K) were recorded. Increase in plant height was recorded by measuring the difference between the initial plant height before start of the experiment and final plant height at the end of the experiment. Five mature leaves were selected randomly from each replication trees$^{-1}$ for determination of leaf area, total chlorophyll content and leaf N, P, K content. Yield per plant was recorded at the harvest stage. Quality parameters such as total soluble solids, titratable acidity and total sugars were also recorded. Experimental data were analysed statistically by following the analysis of variance (ANOVA) method (Panse and Sukhatme 1967).

## RESULTS AND DISCUSSION

*A. Growth attributes*

**(i) Plant height (cm).** Maximum increase in plant height (43.66 cm) was observed in Vermiwash 3% and lowest plant height increase was recorded in control (19.79 cm) (Table 2). The presence of humic acids, fulvic acids, beneficial microorganisms, enzymes, hormones and multi nutrients in Vermi wash promotes plant growth, by further enhancing the metabolic activities and secretion of plant metabolites responsible for cell division and cell enlargements. Similar results were obtained by Thakriya *et al.* (2017) in mango.

**Table 2: Effect of biostimulants on plant height, leaf area and total chlorophyll content of mango *cv*. Imam Pasand under UHDP system.**

| Treatments | Plant height (cm) | Leaf Area (cm$^2$) | Total chlorophyll content (mg/g) |
|---|---|---|---|
| $T_1$ – Seaweed Extract 0.1% | 23.43 | 55.66 | 1.94 |
| $T_2$ – Seaweed Extract 0.2% | 35.62 | 65.07 | 2.40 |
| $T_3$ – Seaweed Extract 0.3% | 29.07 | 61.72 | 2.28 |
| $T_4$ – Panchagavya 1% | 26.80 | 60.37 | 2.02 |
| $T_5$ – Panchagavya 2% | 30.22 | 64.46 | 2.24 |
| $T_6$ – Panchagavya 3% | 34.70 | 70.40 | 2.52 |
| $T_7$ – Fulvic Acid 1% | 27.36 | 58.56 | 1.90 |
| $T_8$ – Fulvic Acid 2% | 36.93 | 66.95 | 2.47 |
| $T_9$ – Fulvic Acid 3% | 32.20 | 62.37 | 2.42 |
| $T_{10}$ – Vermiwash 1% | 33.18 | 69.28 | 2.34 |
| $T_{11}$ – Vermiwash 2% | 38.24 | 74.65 | 2.55 |
| $T_{12}$ – Vermiwash 3% | 43.66 | 76.35 | 2.79 |
| $T_{13}$ – Control (No Biostimulant) | 19.79 | 52.90 | 1.83 |
| SEd | 0.83 | 1.25 | 0.05 |
| CD (P = 0.05) | 1.71 | 2.59 | 0.11 |

**(ii) Leaf Area (cm$^2$).** Foliar application of 3%Vermiwash in Mango trees significantly enhanced the leaf area. Maximum leaf area of 76.35 cm$^2$ was recorded in Vermiwash 3% and the control (52.90 cm$^2$) showed minimum leaf area than other treatments (Table 2). This might be due to presence of different plant growth regulators as well as various nutrient contents in vermiwash which helps in improving the vegetative characters of the plants. Moreover, vermiwash hinders the accumulation of $Na^+$ in plants and provides tolerance to salt stress and maintains the normal growth. Similar results were observed by Singh *et al.* (2010) in Strawberry; Aremu *et al.* (2012) on Banana; El-Hameid and Adel (2018) in Mango; and Bidabadi *et al.* (2017) in Pomegranate.

**(iii) Total Chlorophyll Content (mg/g).** Increased total chlorophyll content was recorded with Vermiwash 3% (2.79 mg/g) and control (1.83 mg/g) shows the lowest chlorophyll content (Table 2). The results may be due to presence of phytohormones and multi nutrients and humic and fulvic acids in vermiwash increased the growth and ultimately photosynthetic efficiency in plants. Vermiwash also had a reduced chlorophyll loss in salt stressed plants which further

increases the photosynthetic efficiency of the plants. Similar results were noticed by El-Hameid and Adel (2018) in Mango; and Bidabadi *et al.,* (2017) in Pomegranate.

**(iv) Leaf Nutrient Content (%).** Application of biostimulants significantly increased the leaf N, P and K content than control. Highest leaf N, P and K were recorded in vermiwash 3% *viz*., N (2.88%), P (0.18%) and K (1.73%) and lowest N (1.72%), P (0.09%) and K (1.73%) in control (Figs. 1, 2 and 3). This might be due to the presence of higher humic acid in vermiwash which resulted in higher absorption of these nutrients. Vermiwash also contains N, P, K as earthworms enhance the nitrogen cycle in soils, mineralize the phosphorous during vermicomposting and change of potassium content from non-exchangeable form to exchangeable form. The obtained results in this study were in agreement with Singh *et al*. (2010) on Strawberry; El-Hameid and Adel (2018) on Mango; Bidabadi *et al*. (2017) on Pomegranate; and Arthur *et al*. (2012) on Tomato.

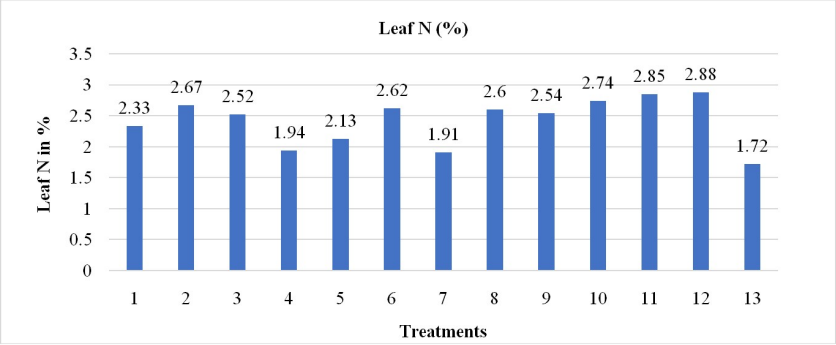


**Fig. 1.** Effect of biostimulants on leaf nitrogen content of mango *cv*. Imam pasand under UHDP system.

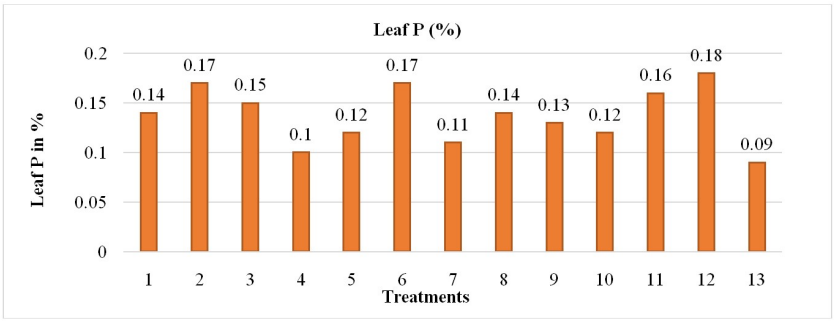


**Fig. 2.** Effect of biostimulants on leaf phosphorous content of mango *cv*. Imam pasand under UHDP system.

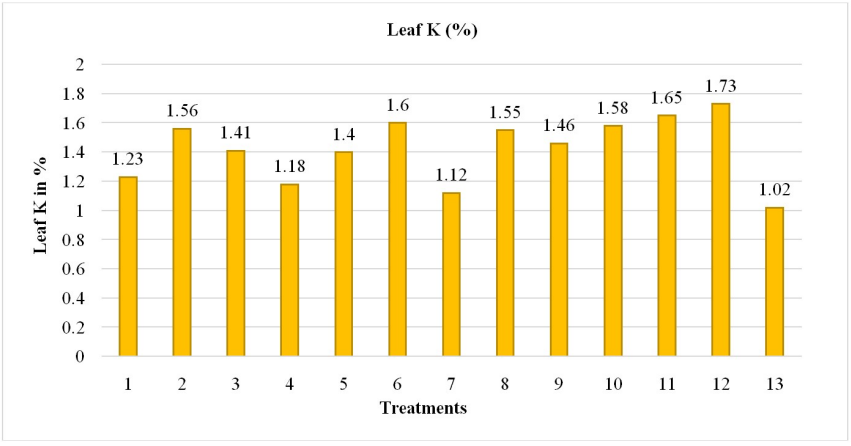


**Fig. 3.** Effect of biostimulants on leaf potassium content of mango *cv*. Imam pasand under UHDP system.

*B. Yield and quality attributes*

**(i) Fruit Yield (kg tree$^{-1}$).** Maximum yield per tree was recorded with Vermiwash 3% (5.60 kg) and minimum yield per tree was recorded with control (2.03 kg) in Mango cultivar Imam Pasand (Table 3). This might be due to presence of enzymes, microorganisms, growth stimulating hormones and multi nutrients such as N, P, K, Ca, Mg, S, Fe, Mn, Zn and Cu in vermiwash. This favours the accelerated mobility of photosynthates from the source to sink which increases the fruit weight of

Mango. Vermiwash also helps in reduction in incidence of various diseases and pests and malformed fruits and it increased the calcium content in cell wall which delay softening and mould growth and contains significant amount of micronutrients. So, it increases number of healthy fruits and hence, increase the yield of trees. Similar results obtained from Strawberry (Singh *et al.,* 2010); Mango (El-Hameid and Adel 2018); Mango (Sathe and Patil 2014) and on Chilli (Sundararasu 2016).

**(ii) Total Soluble Solids (TSS) [° Brix].** Vermiwash at 3% concentration was recorded maximum TSS (19.92 ° Brix) and minimum TSS was recorded in control (16.35 °Brix) (Table 3). This might be due to presence of macro as well as micro nutrients in vermiwash like N, P, K, Mg, Zn, Ca, Fe and Cu and also certain microorganisms. The plant growth regulators which increases the absorption of nutrients from soil and ultimately increased the TSS in fruits. Similar results were recorded by Singh *et.al*, (2010) in Strawberry; and El-Hameid and Adel (2018) on Mango.

**(iii) Titratable acidity (%).** As the fruits ripen, the acidity of fruits decreases, the lowest titratable acidity was observed in Vermiwash 3% (0.20 %) and highest acidity in control (0.29 %) (Table 3). Presence of humic substances in vermiwash helps in the absorption of nutrients from the soil by the plants. The presence of plant hormones like auxins and cytokinin helps in growth and development of fruits, prevents the uptake of toxic elements and the complex substances such as carbohydrates, proteins and fats were converted into simple forms which further increases the quality and reduces the acid content. The obtained results of this study were in agreement with Singh *et.al*, (2010) in Strawberry, Sathe and Patil (2014) on Mango, El-Hameid and Adel (2018) on Mango; and Dheware *et al.,* (2020) on Mango.

**(iv) Total Sugars.** Highest total sugars was recorded in Vermiwash 3% (14.41%) and lowest in control (10.66%) (Table 3). It happens because of higher amount of simple sugars in ripen fruits which are being formed by breakdown of the complex molecules like carbohydrates. This was induced by vermiwash due to presence of certain microorganisms which produces ripening enzymes and hormones. Vermiwash provides a variety of macro and micro nutrients that are readily available to plants by foliar spray, and the humic compounds included in vermiwash boost nutrient absorption and improve the physiological processes of fruit ripening, eventually increasing total sugars in fruits. Similar results were obtained from Singh *et.al*, (2010) in Strawberry, Sathe & Patil, (2014) on Mango and El-Hameid and Adel, (2018) on Mango.

**Table 3: Effect of biostimulants on yield and quality of the fruits of mango *cv*. Imam Pasand under UHDP system.**

| Treatments | Fruit Yield (kg tree$^{-1}$) | TSS (° Brix) | Titrable Acidity (%) | Total Sugars (%) |
|---|---|---|---|---|
| $T_1$ – Seaweed Extract 0.1% | 2.48 | 17.21 | 0.26 | 11.07 |
| $T_2$ – Seaweed Extract 0.2% | 4.27 | 18.35 | 0.23 | 13.15 |
| $T_3$ – Seaweed Extract 0.3% | 3.38 | 17.55 | 0.24 | 12.68 |
| $T_4$ – Panchagavya 1% | 2.61 | 17.22 | 0.26 | 10.95 |
| $T_5$ – Panchagavya 2% | 3.44 | 17.37 | 0.25 | 12.26 |
| $T_6$ – Panchagavya 3% | 4.69 | 18.85 | 0.22 | 13.85 |
| $T_7$ – Fulvic Acid 1% | 3.12 | 16.84 | 0.27 | 11.15 |
| $T_8$ – Fulvic Acid 2% | 4.35 | 18.42 | 0.23 | 13.70 |
| $T_9$ – Fulvic Acid 3% | 3.64 | 17.31 | 0.25 | 12.10 |
| $T_{10}$ – Vermiwash 1% | 3.70 | 17.61 | 0.24 | 12.45 |
| $T_{11}$ – Vermiwash 2% | 5.19 | 19.15 | 0.21 | 14.30 |
| $T_{12}$ – Vermiwash 3% | 5.60 | 19.92 | 0.20 | 14.41 |
| $T_{13}$ – Control (No Biostimulant) | 2.03 | 16.35 | 0.29 | 10.66 |
| SEd | 0.09 | 0.42 | 0.02 | 0.24 |
| CD (P = 0.05) | 0.18 | 0.87 | 0.03 | 0.50 |

## CONCLUSION

From the above results, it is clearly indicated that all biostimulants had a positive effect on the Mango *cv.* Imam Pasand growth, yield and quality. Foliar application of Vermiwash 3% recorded maximum plant height; maximum leaf area, total chlorophyll content and leaf nutrient content. Furthermore, vermiwash 3% recorded higher yield and fruit quality such as TSS, total sugars and lower titratable acidity compared to other treatments. Hence foliar application of Vermiwash 3% can be recommended for Mango *cv.* Imam Pasand for better crop growth, yield and quality.

## FUTURE SCOPE

To completely understand the mode of action of the biostimulant, Vermiwash 3 %, which will further boost the growth, flowering, and quality, more research is needed. To effectively communicate the study findings about biostimulants, several agricultural universities and research institutes should perform a variety of extension programmes.

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**Conflict of Interest.** None.

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