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## EFFECT OF FOLIAR APPLICATION OF DIFFERENT BORON SOURCES ON FLOWERING, FRUITING AND QUALITY CHARACTERISTICS OF MANGO CV. AMRAPALLI IN NAGALAND, INDIA

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### ABSTRACT

During January 2022 - August 2022, a field experiment was conducted at the Horticultural farm, School of Agricultural Sciences, Nagaland University, Medziphema Campus to assess the effect of foliar application of different boron sources on flowering, fruiting and quality characteristics of mango in Nagaland. The experiment was laid out in Randomized Block Design with 3 replications and 8 treatments. The fruit trees were subjected to foliar spray at flowering stage, pea size stage and marble stage. Results confirmed that as compared to control, a significant improvement in flowering characteristics viz., panicle initiation and male flowers/panicles (227.33) confirmed the effectiveness of Agricol (0.2%), whereas hermaphrodite flower/panicle were found significantly highest (208.66) with the treatment of Boric acid (0.2%). Likewise, in fruiting characteristics, minimum days taken to fruit set (63.33 days), number of fruits/panicle (5.33) at harvest were found significantly with the treatment of Agricol (0.2%). The treatment via Agricol (0.2%) showed significantly superior fruit quality traits evaluated in terms of, total sugar (18.39%), and Beta-carotene (3343.24 µg/100g). Based on the results, it may be concluded that Agricol (0.2%) followed by DOT (0.4%) was more remunerative in comparison to other treatments to improve on flowering, fruiting and quality characteristics. Generally, lower concentration of Boron performed better than higher concentration.

**Key words :** Mango, Mineral Boron, Flowering, Fruiting, Quality characteristics.

### Introduction

Mango (*Mangifera indica*) belongs to the family *Anacardiaceae*. It is an important fruit crop known to be the king of fruit due to its fragrance, sweetness and nutritional values. It is believed to be originated in Indo-Malayan region (Mukherjee, 1985). Several hundred cultivars of mango are present worldwide. Mango fruit can vary in size, shape, flavour, skin tone and flesh colour depending on the cultivar. The fruit is tart, crispy and dry like the green apples during its unripe stage (Wijeratnam *et al.*, 2015). Flowering and pollination are key events for mango fruit development to occur (Ramirez *et al.*, 2010). It serves as a good source of vitamin and energy as in vitamin A (3894 IU), vitamin C (27.2 mg/100g) and minerals like iron (0.13 mg/100g) and phosphorus (11 mg/100g), (Anonymous, 2001). According to 2021-2022

census, Mango has an area of about 2339 ha and production of 20336 MT in India. Uttar Pradesh rank first in mango production with share of 23.58 per cent and the highest productivity in 2021-2022 (Anonymous, 2023). In Northeast India, Nagaland, mango has an area of 0.54 ha, and a production of 3.56 t/ha (Anonymous, 2021). Over the decades using the same kind of chemical fertilizers led the serious problem of micronutrient deficiencies in soils and plants worldwide (Sharma *et al.*, 2026). It is also affecting the flowering, fruiting, quality and post-harvest life of characteristics of horticultural products (Raja, 2009). Micronutrients have an important role in plant metabolism, reproductive growth, chlorophyll synthesis, carbohydrate metabolism, fruit and seed development etc. Besides these, boron and molybdenum deficiency have also been reported in several part on

India. In Nagaland, low crop productivity is due to nutrient deficiencies in soil-crop contexts and inappropriate management reported by (Shukla *et al.*, 2021). Boron plays a pivotal role in the growth and expansion of reproductive cells, the beginning of flowering, and the movement of sugars. Its shortage occurs during flowering and seed set and is typically momentary. The widespread occurrence of Boron deficiency has been identified as one of the main causes of poor yield and quality of Alphonso Mango (Raja and Kumar, 2003). However, efficient micronutrient management, including soil and foliar administration of micronutrients, in various soil-crop situations could help in reducing micronutrient deficiencies in soils and crops, boosting crop output and crops quality. Under the agro-climatic conditions of Nagaland, limited research information is available related to the effect of micronutrient on mango in Northeast India. Keeping this in view, the current study was conducted to examine the effect of foliar application of different boron sources on flowering, fruiting and quality characteristics of mango

### Materials and Methods

The experiment was carried out in the Instructional Farm, SAS, NU, Medziphema having an altitude of 305 m above mean sea level, with geographical location of 25° 45' 43" N and 93° 53' 04" E. The area enjoys the high humidity, moderate temperature and medium to high rainfall during the season. Meteorological data obtained from ICAR, Nagaland Centre, Jharnapani showed that during the period of investigation, temperature ranges between 12°C during winter to 32°C during summer, average annual rainfall ranges from 150 to 250 cm and high relative humidity of 65-85%. The soil of the experimental site was sandy loam in texture and well-drained with pH of 4.5. The experiment was laid out in Randomized Block Design with 3 replications and 8 treatments viz., T<sub>1</sub> (Agricol 0.2%), T<sub>2</sub> (Agricol 0.4%), T<sub>3</sub> (Chemibor-P 0.2%), T<sub>4</sub> (Chemibor-P 0.4%), T<sub>5</sub> (Disodium Octaborate Tetrahydrate 0.2%), T<sub>6</sub> (Disodium Octaborate Tetrahydrate 0.4%), T<sub>7</sub> (Boric acid 0.2%) and T<sub>8</sub> (control -distilled water). 24 uniform trees of mango cv. Amrapalli about 20 years old were selected for the experiment. The aqueous solutions of various treatments were prepared and applied in three split doses on the tree; first dose during flowering stage, second dose at pea size stage of fruit and the third dose at marble stage of fruit with the help of knapsack sprayer. The final data of flowering, fruiting and quality characteristics recorded carefully by standard procedure during the investigation were analysed statistically by the method of analysis of variance (ANOVA) and the significance sources of variation were tested by error mean square using 'F' test (Sukhatme

and Panse, 2000).

## Results and Discussion

### Flowering characteristics

Data presented in Table 1 indicated that significantly higher number of male flower (227.33) was recorded with agricol (0.2%) application followed by treatment with boric acid at 0.2% (200.33). The least number of male flowers per panicle (108.67) was noted in control. Similarly, maximum hermaphrodite flower per panicle (208.66) was found significantly in cv. Amrapalli mango with Boric acid (0.2%) application closely followed by DOT at 0.4% application (180.33). Minimum number of hermaphrodite flowers per panicle (102.00) was recorded in control. Boron is involved in metabolism, protein synthesis and the highest concentration of amino acids, which may be the cause of the greatest number of blooms. Similar results were found in Negi *et al.* (2010) reported in mango cv. Dashehari that spraying of boric acid 200 ppm recorded the maximum percentage of hermaphrodite flowers similarly, spraying of Calcium-boron concentrations of either 3.0 or 4.0 mL/L produced the highest number of hermaphroditic flowers (76.75% ± 11.93) in mango cv. Mahachanok (Muengkaew *et al.*, 2017). Similar kinds of trends reported by Talang *et al.* (2016), Ali *et al.* (2017), Ahmad *et al.* (2018), Gopavaram *et al.* (2022), Deb and Reza (2023), Deb *et al.* (2024).

### Fruiting characteristics

Data presented in Table 1 indicated that significantly minimum number of days (63.33) for fruit set was found in treatment Agricol (0.2%) followed by Agricol (0.4%) with 65.33 days and Chemibor P at 0.2% (65.66 days) which were all found to be statistically same. The maximum period of days taken from panicle initiation to fruit set (94.66) was found in control. Similarly, the

**Tables 1 :** Influence of different boron sources on flowering characteristics of Mango cv. Amrapalli.

| Treatments               | Male flowers/<br>panicle | Hermaphrodite<br>flowers/panicle |
|--------------------------|--------------------------|----------------------------------|
| <b>Agricol (0.2%)</b>    | 227.33                   | 170.00                           |
| <b>Agricol (0.4%)</b>    | 154.60                   | 156.00                           |
| <b>Chemibor-P (0.2%)</b> | 198.66                   | 178.33                           |
| <b>Chemibor-P (0.4%)</b> | 170.00                   | 160.00                           |
| <b>DOT (0.2%)</b>        | 188.66                   | 170.33                           |
| <b>DOT (0.4%)</b>        | 175.00                   | 180.33                           |
| <b>Boric acid (0.2%)</b> | 200.33                   | 208.66                           |
| <b>Control</b>           | 108.67                   | 102.00                           |
| <b>SEm±</b>              | <b>4.62</b>              | <b>7.36</b>                      |
| <b>CD at 5%</b>          | <b>14.01</b>             | <b>22.32</b>                     |

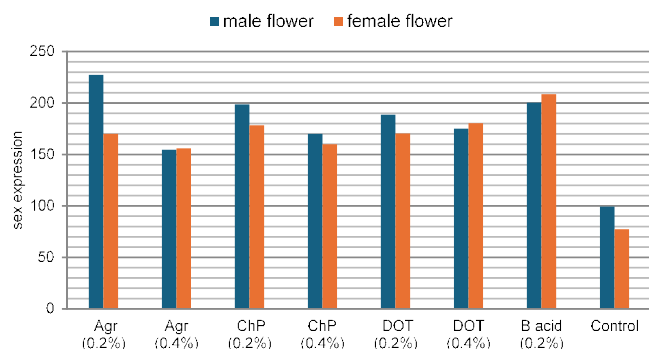


**Fig. 1 :** Influence of boron sources on sex expression.

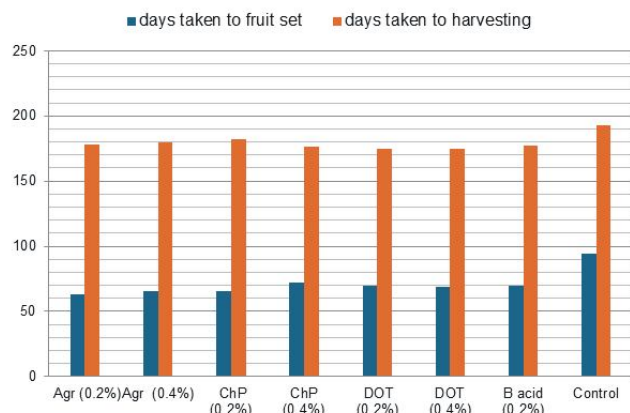


**Fig. 2 :** Influence of boron sources on days taken to fruit set and days taken to harvesting.

minimum number of days (174.66) for harvesting was found in treatment DOT (0.4%) followed by DOT (0.2%) with 175.0 days closely followed by application of Chemibor P (0.4%) and Boric acid (176.66 and 177.33 days, respectively), which were all found to be statistically at par. The maximum number of days taken from panicle initiation to harvesting (192.66) was found in control plants. Likewise, number of fruits at harvest per panicle. The

**Tables 2 :** Influence of different boron sources on fruiting characteristics of Mango cv. Amrapalli.

| Treatments               | Number of days taken to fruit set (days) | Number of days taken to harvest (days) | Number of fruits per panicle at harvest |
|--------------------------|------------------------------------------|----------------------------------------|-----------------------------------------|
| <b>Agricol (0.2%)</b>    | 63.33                                    | 178.00                                 | 5.33                                    |
| <b>Agricol (0.4%)</b>    | 65.33                                    | 179.66                                 | 3.17                                    |
| <b>Chemibor-P (0.2%)</b> | 65.66                                    | 182.33                                 | 4.33                                    |
| <b>Chemibor-P (0.4%)</b> | 72.00                                    | 176.66                                 | 3.67                                    |
| <b>DOT (0.2%)</b>        | 69.33                                    | 175.00                                 | 3.43                                    |
| <b>DOT (0.4%)</b>        | 68.66                                    | 174.66                                 | 5.00                                    |
| <b>Boric acid (0.2%)</b> | 69.66                                    | 177.33                                 | 4.10                                    |
| <b>Control</b>           | 94.66                                    | 192.66                                 | 1.50                                    |
| <b>SEm±</b>              | <b>1.74</b>                              | <b>0.97</b>                            | <b>0.63</b>                             |
| <b>CD at 5%</b>          | <b>5.29</b>                              | <b>2.95</b>                            | <b>1.91</b>                             |

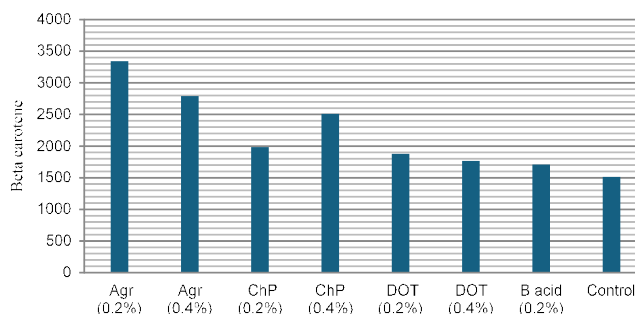


**Fig. 3 :** Influence of boron sources on the Beta-carotene (µg/100 g) content.

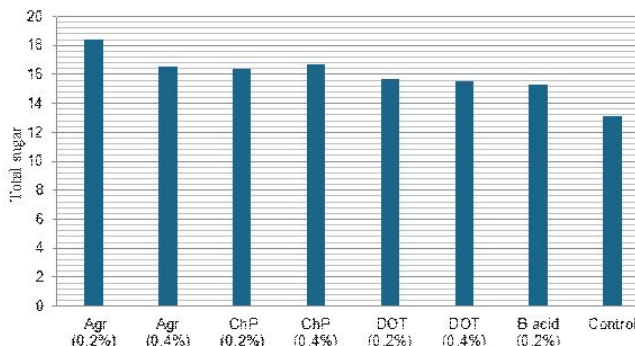


**Fig. 4 :** Influence of boron sources on total sugar content (%).

maximum number of fruits set per panicle (5.33) was noted in Agricol (0.2%) followed by DOT (0.4%) (5.00), Chemibor-P (0.2%) (4.33), Boric acid (0.2%) (4.10), Chemibor-P (0.4%), DOT (0.2%) (3.43) fruits at harvest per panicle which were statistically same. The minimum number of fruits at harvest per panicle (1.50) was found in control. Talang *et al.* (2017) reported in mango cv. Himsagar treated with boric acid (0.02%) recorded the most effective for enhancing fruit-set (1.58%). The higher number of fruits set per panicle was also associated with the greater number of flower formation due to boron absorption and they also set a greater number of fruits (Sarrwy *et al.*, 2012). Similar results have been reported by Ahmad *et al.* (2018), Bibi *et al.* (2019), Haider *et al.* (2019), Palak *et al.* (2020), Gopavaram *et al.* (2022), Singh *et al.* (2023) and Deb and Reza (2024).

### Quality characteristics

Data presented in Table 3 indicated that maximum total sugar (18.39%) was found in treatment agricol (0.2%), which was statistically at par with Chemibor-P 0.4% (16.67%), agricol 0.4% (16.56), Chemibor-P 0.2% (16.39%), while the minimum total sugars percentage (13.11%) was observed in treatment control. Maximum total sugar content in mango fruit maybe due to boron accelerating the transit of sugar, the synthesis of metabolites, and the quick translocation of photosynthates. The greatest percentage of total sugar was likely boosted by the conversion of starch to sugar. Likewise, the

**Tables 3 :** Influence of different boron sources on quality characteristics of Mango cv. Amrapalli.

| Treatments               | TSS (°Brix) | Acidity (%) | TSS: acid | Total sugar % | Reducing sugar % | Non-reducing sugar % | Vit- C (mg/100g) | Beta carotene (µg/100g) |
|--------------------------|-------------|-------------|-----------|---------------|------------------|----------------------|------------------|-------------------------|
| <b>Agricol (0.2%)</b>    | 20.78       | 0.25        | 83.12     | 18.39         | 4.70             | 13.73                | 47.59            | 3343.24                 |
| <b>Agricol (0.4%)</b>    | 19.45       | 0.27        | 72.03     | 16.56         | 3.56             | 13.12                | 31.53            | 2792.85                 |
| <b>Chemibor-P (0.2%)</b> | 18.75       | 0.32        | 58.59     | 16.39         | 5.16             | 11.10                | 42.43            | 1984.28                 |
| <b>Chemibor-P (0.4%)</b> | 19.16       | 0.32        | 59.87     | 16.67         | 4.01             | 12.61                | 37.27            | 2509.52                 |
| <b>DOT (0.2%)</b>        | 20.11       | 0.29        | 69.34     | 15.67         | 4.06             | 11.47                | 36.69            | 1878.05                 |
| <b>DOT (0.4%)</b>        | 18.95       | 0.33        | 57.42     | 15.50         | 3.94             | 11.44                | 34.97            | 1766.44                 |
| <b>Boric acid (0.2%)</b> | 19.78       | 0.31        | 63.80     | 15.33         | 3.41             | 11.77                | 32.68            | 1708.09                 |
| <b>Control</b>           | 16.82       | 0.36        | 46.72     | 13.11         | 3.26             | 9.21                 | 29.67            | 1513.81                 |
| <b>SEm±</b>              | <b>0.94</b> | <b>0.07</b> | -         | <b>0.67</b>   | <b>0.47</b>      | <b>0.96</b>          | <b>5.92</b>      | <b>338.37</b>           |
| <b>CD at 5%</b>          | <b>NS</b>   | <b>NS</b>   | -         | <b>2.04</b>   | <b>NS</b>        | <b>NS</b>            | <b>NS</b>        | <b>1026.34</b>          |

greatest beta carotene (3343.24 µg/100g) were obtained with the foliar application of Agricol (0.2%) which was statistically at par with Agricol 0.4% (2792.85 µg/100g), chemibor-P 0.4% (2509.52 µg/100g). The minimum beta carotene (1513.81 µg/100 g) was recorded in control. The fact that boron speeds up ripening may be the cause of the greater beta carotene level. This result correlates with the finding of Patel *et al.* (2016), Talang *et al.* (2016), Shaban *et al.* (2017), Khan *et al.* (2022), Almutairi *et al.* (2023) and Kumar *et al.* (2025).

### Conclusion

In flowering characteristic, Boric acid (0.2%) as foliar spray produced greatest hermaphrodite flower/panicle and the application of Agricol (0.2%) produced greater number of male flowers/panicles. All the fruiting characteristic showed best result with the foliar application of Agricol (0.2%). Similarly, the qualitative characteristics of mango cv. Amrapalli was enhanced with foliar spray of Agricol and Chemibor-P at both concentrations under present study. Based on above the results, it may be concluded that foliar application of Agricol (0.2%) was more remunerative in comparison to other treatments to improve on flowering, fruiting and quality characteristics. The result suggested that, lower concentration of Boron performed better than higher concentration.

### Conflict of interest

All the author declares that there is no conflict of interest related to this article.

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### References

- Ahmad, I., Bibi F., Ullah H. and Munir T.M. (2018). Mango Fruit Yield and Critical Quality Parameters respond to Foliar and Soil Applications of Zinc and Boron. *Plants*, **7**(4), 97.
- Ali, M.S., Elhamahmy M.A. and El-Shiekh A.F. (2017). Mango trees productivity and quality as affected by boron and putrescine. *Scientia Horticulturae*, **216**, 248-255.
- Almutairi, K.F., Górnik K., Ayoub A., Abada H.S. and Mosa W.F. (2023). Performance of mango trees under the spraying of some biostimulants. *Sustainability*, **15**(21), 15543.
- Annoymous (2023). *Area and production statistics of horticulture crops*. [https://apeda.gov.in/apedawebsite/SubHead\\_Products/Mango.htm](https://apeda.gov.in/apedawebsite/SubHead_Products/Mango.htm). Accessed on may 2023.
- Anonymous (2001). *Nutrient Database for Standard Reference*. United States Department of Agriculture. Washington DC.
- Bibi, F., Ahmad I., Bakhsh A., Kiran S., Danish S., Ullah H. and Rehman A.U. (2019). Effect of foliar application of boron with calcium and potassium on quality and yield of mango cv. summer bahisht (SB) Chaunsa. *Open Agriculture*, **4**(1), 98-106.
- Deb, P. and Reza S. (2023). Pre flowering Sprays of Zinc and Boron Influenced Panicle Emergence and Panicle growth of Amrapali Mango. *Research Biotica*, **5**(2), 79-84.
- Deb, P. and Reza S. (2024). Effect of pre-flowering sprays of micronutrients on flowering, fruit set, fruit drop and yield of mango cv. Amrapali. *Crop Research (0970-4884)*, **59**.
- Deb, P., Mukherjee P.K. and Das P. (2024). Panicle diversity of some mango varieties under semi-arid lateritic belt of Eastern India. *Int. J. Minor Fruits, Medicinal and Aromatic Plants*, **10**(1), 102-111.
- Gopavaram, Pavithra, Pauline Alila, Maiti C.S., Sarkar A. and Sahu A.K. (2022). Effect of different sources of boron on flowering and yield of mango cv. Amrapali. *Pharma*

- Innovation*, **11**(4), 909-913.
- Haider, Z., Ahmad N., Danish S., Iqbal J., Ali M.A. and Chaudhry U.K. (2019). Effect of foliar application of boric acid on fruit quality and yield traits of mango. *Adv. Hortic. Sci.*, **33**(4), 457-464.
- Khan, M.M.H., Ahmed N., Ghafoor U., Ali M., Ali M.A., Irfan M. and Datta R. (2022). Synchronization of Boron application methods and rates is environmentally friendly approach to improve quality attributes of *Mangifera indica* L. on sustainable basis. *Saudi J. Biolog. Sci.*, **29**(3), 1869-1880.
- Kumar, A., Sengupta S., Yadav B., Rai A.K., Bhusari R.M., Gore V.B. and Gawhale B.J. (2025). Influence of foliar application of plant growth regulators on fruit retention, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali. *Plant Archives*, **25**(1), 1113-1120.
- Muengkaew, R., Chaiprasart P. and Wongsawad P. (2017). Calcium-Boron addition promotes pollen germination and fruit set of Mango. *Int. J. Fruit Sci.*, **17**(2), 147-158.
- Mukherjee, S.K. (1985). Systematic and eco-geographical studies on crop gene pools. Malik, A.U. and Singh Z. (2006). Improved fruit retention, yield and fruit quality in mango with exogenous application of polyamines. *Science Horticulture*, **110**, 167-174.
- Negi, S.S., Singh A.K. and Singh C.P. (2009). Effect of foliar application of nutrients on fruit-set, yield and quality of mango cv. Dashehari. *Haryana J. Hortic. Sci.*, **38**(1), 20-22.
- Palak, K., Patel B.N., Bhanderi D.R. and Dharmishtha P. (2020). Effect of foliar spray of silicon and boron on fruiting and yield of rejuvenated mango (*Mangifera indica* L.) cv. Sonpari. *IJCS*, **8**(4), 1421-1425.
- Panse, V.G. and Sukhatme P.V. (2000). *Statistical Methods for Agricultural Workers*. 4th ed. ICAR, New Delhi, 157-165.
- Patel, A. (2016). Effect of micronutrient on growth, yield and quality of mango cv. Amrapalli. *M.Sc. Thesis* submitted to Jawaharlal Nehru Krishi Vishwavidyalaya.
- Raja, E. and Kumar A. (2003). Boron deficiency- a serious yield-limiting factor in alphonso mango of Konkan, Maharashtra. *Soil Sci. Plant Nutr.*, **51**(5), 751-754.
- Raja, M.E. (2009). Importance of Micronutrients in the Changing Horticultural Scenario in India. *J. Hortic. Sci.*, **4**(1), 1-27.
- Sarrwy, S.M., El-Sheikh M.H.S., Kabeil S. and Shamseldin A. (2012). Effect of foliar application of different potassium forms supported by zinc on leaf mineral contents, yield and fruit quality of "Balady" mandrine trees. *Middle-East J. Sci. Res.*, **12**(4), 490-498.
- Shaban, A.E., El-Motaum R.A., Badawy S.H. and Ibrahim A.S. (2017). Improvement of mango (*Mangifera indica* L.) fruit quality and yield using boron foliar application. *Biosci. Res.*, **14**(3), 478-484.
- Sharma, J., Gupta H. and Patle U. (2026). Effect of foliar spray of zinc and iron on the productivity of spring cowpea. *J. Agricult. Ecol.*, **22**, 116-121.
- Shukla, A.K., Behera S.K., Tripathi A., Rao C.N. and Das S. (2021). Deficiency of phyto-available sulphur, zinc, boron, iron, copper and manganese in soils in India. *Scientific Report*.
- Singh, S.S., Tripathi V.K. and Awasthi M. (2023). Influence of Pre-harvest Application of Gibberellic Acid and Borax on fruit retention, yield and quality of Mango (*Mangifera indica* L.) cv. Dashehari. *Biological Forum-An Int. J.*, **15**(9), 287-291.
- Talang, H.D., Dutta P., Mukhim C. and Patil S. (2016). Effect of calcium, boron and sorbitol on fruit-set, yield and quality in mango cv. Himsagar. *J. Hortic. Sci.*, **11**(2), 166-169.
- Talang, H.D., Dutta P., Mukhim C. and Patil S. (2016). Effect of calcium, boron and sorbitol on fruit-set, yield and quality in mango cv. Himsagar. *J. Hortic. Sci.*, **11**(2), 166-169.
- Talang, H.D., Dutta P., Mukhim C. and Patil S. (2017). Effect of calcium, boron and sorbitol on fruit-set, yield and quality in mango cv. Himsagar. *Hortic. Sci.*, **11**(2), 166-169.
- Wijeratnam, S., Gunasekera N. and Gunathilaka S. (2015). Improving quality of mango var. Karthakolomban by postharvest application of new edible wax formulations. *Biennial Research Symposium*.