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KH Sharathkumar
Department of Fruit Science, COH, Bengaluru, Karnataka, India

K Ajay Kumar
Department of Fruit Science, COH, Bengaluru, Karnataka, India

MD Sandeep
Department of Fruit Science, Anand Agricultural University AAU, Gujarat, India

YB Shiva Kumar
Department of Vegetable Science, Kerala Agricultural University, Thrissur, Kerala, India

Corresponding Author:
KH Sharathkumar
Department of Fruit Science, COH, Bengaluru, Karnataka, India

Effect of foliar spray of potassium and micronutrients on nutrient content (Petiole analysis) and uptake in petiole of papaya (*Carica papaya* L.) cv. red lady

KH Sharathkumar, K Ajay Kumar, MD Sandeep and YB Shiva Kumar

Abstract
The present investigation entitled that "Effect of foliar spray of potassium and micronutrients on nutrient content (petiole analysis) and uptake in petiole of papaya (*Carica papaya* L.*) cv*. Red Lady" was carried out in Farmer's field at Basur village, Sorab taluk, Shivamogga dist, during the year 2018-2019. The experiment was laid out in randomized complete block design with three replication and eleven treatments. Results reveal that the combined application of T_7 - K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25% recorded significantly maximum nutrient content of macro and micro nutrients *i.e.* Nitrogen (1.33%), Phosphorus (0.20%), Potassium (3.35%), Calcium (1.45%), Magnesium (0.62%) and Sulphur (0.43%) and uptake of macro and micro nutrients *i.e.* Nitrogen (19.39kg ha^{-1}), Phosphorous (2.92kg ha^{-1}), Potassium (48.84kg ha^{-1}), calcium (21.14kg ha^{-1}), Magnesium (9.04kg ha^{-1}), Sulphur (6.27kg ha^{-1}), Boron (58.80g ha^{-1}), Copper (4.11g ha^{-1}), Manganese (26.07g ha^{-1}) and Iron (72.71g ha^{-1}) over control and which was on par with T_8 (K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%). A significant difference was observed in Zinc (19.69g ha^{-1}) with the combined application of T_8 (K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%) over control and which was on par with T_7. Among the different micronutrient application, the treatment T_7 - K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25% was found to be effective to improve the nutrient content (petiole analysis) and uptake in petiole of papaya *cv*. Red Lady.

Keywords: Papaya, potash, micro nutrients, uptake

Introduction
Papaya (*Carica papaya* L.) is an important fruit of tropical and subtropical regions of the world, belonging to the family Caricaceae and also known as "wonder fruit of the tropics" (Parmar *et al.*, 2017) [14]. It is native of Tropical America was introduced to India in the 16th century from Malacca (Singh, 1990) [19]. India is the largest producer of papaya in the world producing 5.83 million MT of fruits from an area of 0.13mha with productivity of 42.3 MT/ ha (NHB, 2019). Karnataka is the third largest producer of papaya in the country. It is commercially cultivated in Andhra Pradesh, Gujarat, Karnataka, West Bengal, Madhya Pradesh, Maharashtra and Tamil Nadu. Papaya fruits are also good source of many minerals (potassium, phosphorus and magnesium) in human diet. The papaya fruit belongs to the group of low acid content fruit and the pH of pulp ranges from 5.5 to 5.9 (Chan *et al.*, 1971) [3].
Potassium regulates the opening and closing of the stomata by a potassium ion pump. Since stomata are important in water regulation, potassium reduces water loss from the leaves and increases drought tolerance. Potassium regulates starch synthesis and sugar accumulation by activating enzymes *viz.*, starch synthetase, *etc*., (Lester *et al.*, 2010) [9]. Adequate K nutrition has also been associated with increased yields, fruit size, increased soluble solids and ascorbic acid concentrations, improved fruit colour, increased shelf life, and shipping quality of many horticultural crops (Geraldson, 1985; Ganeshamurthy *et al.*, 2011) [6, 5]. Transportation of photo assimilates from source tissues via the phloem to sink tissues, enzyme activation, turgor maintenance, and stress tolerance (Marschner, 1995) [10]. The potassium increases root growth, builds cellulose, protein content of plants, food formation and reduces respiration, water loss, energy loss, lodging, wilting which leads to retard crop diseases.
Micronutrients can tremendously increase crop yield and get better quality and post-harvest life of produce. They play a significant role in disease resistance, since they function as enzyme activators and also play a function in lignin biosynthesis (Parmar *et al.*, 2017) [14]. Zinc is required for the activity of different enzymes, including dehydrogenases, aldolases, isomerases, transphosphorylases, RNA and DNA polymerases are involved in the synthesis of

tryptophan, cell division, maintenance of membrane structure and photosynthesis, and acts as a regulatory cofactor in protein synthesis and boron play a very important role in germination of pollen grains, elongation of pollen tube, higher fruit set and are also indirectly responsible for the activation of dehydrogenase enzymes, sugar translocation, nucleic acids and plant hormones (Marschner, 2012) [11]. Zinc and Boron occupies an important place due to its ability to positively influence plant growth and development and imparts resistance to biotic and abiotic stresses (Cakmak, 2008) [2].

The uptake of nutrients through the stomata of the leaf is significantly faster than the roots. The amount of nutrients absorbed though the leaf is small; its efficiency rate is higher than soil application and cost effective. Foliar application of micronutrients is found to be effective 6 to 20 times than that of soil application (Kumar *et al.*, 2011) [8]. For successful commercial cultivation of improved high yielding varieties of papaya crop mainly depends on critical nutrient management due to its continuous growth, flowering and fruiting habit (Parmar *et al.*, 2017) [14]. Hence, foliar application of potassium, zinc and boron in specific plant developmental and critical stages improves the nutrient content (petiole analysis) and uptake in petiole of papaya *cv*. Red Lady.

Materials and Methods

An investigation was carried out in Farmer's field at Basur village, Sorab taluk, Shivamogga dist with the support of Department of Fruit science at College of Horticulture, Bengaluru, University of Horticultural Sciences, Bagalkot during 2018-2019. The experiment was laid out in randomized block design with three replications and eleven treatments *viz.*, T_1 - K_2SO_4 at 1%, T_2 - K_2SO_4 at 2%, T_3 - Borax at 0.25%, T_4 - Borax at 0.50%, T_5 - $ZnSO_4$ at 0.25%, T_6 - $ZnSO_4$ at 0.50%, T_7 - K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%, T_8 - K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%, T_9 - K_2SO_4 at 1% + Borax at 0.50% + $ZnSO_4$ at 0.50%, T_{10} - K_2SO_4 at 2% + Borax at 0.50% + $ZnSO_4$ at 0.50%, T_{11} - Control (water spray) with a spacing 2 x 2 m. Three plants per replication were randomly selected and tagged in each treatment and in each replication. The fruits were harvested based on their maturity indices *viz.*, change in colour of fruit from dark green to yellowish orange. Observations were recorded and statistically analyzed as per the methods given by Panse and Sukhatme (1967) [13].

Results and Discussion

The results on effect of foliar application of potassium and micronutrients on nutrient content (petiole analysis) and uptake in petiole of papaya were significantly influenced by spraying of different concentration of potassium, zinc and boron are recorded and presented in Table 1, 2, 3 and 4 respectively.

Among different treatments (Table 1), the results clearly showed that the macronutrients content were found significantly maximum Nitrogen (1.33%), Phosphorus (0.20%), Potassium (3.35%), Calcium (1.45%), Magnesium (0.62%) and Sulphur (0.43%) were recorded in treatment T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%), which were on par (0.32%, 0.31%, 0.28% and 0.28%, respectively) for N with (T_5, T_6, T_8 and T_9 treatments, respectively), P with all treatments except (T_4, T_{10} and T_{11}), Calcium with T_8 (1.43%) and Potassium, Magnesium and Sulphur with no treatments. Whereas, T_{11} (control-water spray) has registered significantly minimum Nitrogen (1.25%), Phosphorus (0.17%), Potassium (2.75%), Calcium (1.10%), Magnesium (0.40%) and Sulphur (0.23%). Among different treatments, the results clearly showed that the micronutrients were found statistically significant are given in the Table 2. The maximum zinc (13.83ppm) was recorded in T_6 ($ZnSO_4$ at 0.50%) and maximum copper (2.82ppm), manganese (17.88ppm) and iron (49.87ppm) were recorded in T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%) and maximum boron (42.67ppm) was recorded in T_{10} (K_2SO_4 at 2% + Borax at 0.50% + $ZnSO_4$ at 0.50%). Whereas, the minimum zinc (9.93ppm), copper (2.41ppm), manganese (16.55ppm), iron (40.07ppm) and boron (42.67ppm) were observed in T_{11} (control-water spray). This might be due to be due to luxuriant growth and yield leading to high biomass production resulting in a dilution effect and absorption of good amount of nitrogen by the leaves and synergistic effect between N and Zn, and antagonistic effect between N:P and N: K (Singh and Ahlawat, 1995) [20] and it is also due to increase in photosynthetic compounds and leaf chlorophyll helps in leaf bud formation, cell division, cell enlargement and cell wall development of plant and leaf tissue which enhances more accumulation of petiole macro and micronutrients content (Sajid *et al.* 2010) [16]. These results were in conformity with Singh *et al.* (2002) [17] and also might be due to translocation of nutrients from vegetative parts to reproductive parts (Reddy *et al.*, 2010) [15].

Considering the dry matter yield and nutrient content in petiole of papaya, uptake of N, P, K, Ca, Mg, S, Zn, Cu, Mn, Fe and B were recorded and presented in table 3 and 4. The data indicated that uptake of nutrients was significantly influenced by potassium, zinc and boron. Among different treatments, the results clearly showed that the uptake of nitrogen was significantly maximum (19.39kg ha^{-1}) in T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%), which was on par (18.45kg ha^{-1}) with T_5 ($ZnSO_4$ at 0.25%), (18.41kg ha^{-1}) with T_8 (K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%). Whereas, in T_{11} (control-water spray) was recorded maximum uptake of nitrogen (14.48 kg ha^{-1}).

The results of analyzed data, pertaining to uptake of phosphorous, potassium and calcium (2.92kg ha^{-1}, 48.84kg ha^{-1} and 21.14kg ha^{-1}, respectively) were found to be statistically significant in the treatment T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%), which were on par (2.71kg ha^{-1}, 46.52kg ha^{-1} and 20.41kg ha^{-1} respectively) with T_8 (K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%). Whereas, minimum uptake of phosphorous, potassium and calcium (1.97kg ha^{-1}, 31.85kg ha^{-1} and 12.74kg ha^{-1}, respectively) were observed in T_{11} (control-water spray).

The perusal of the data indicates that the uptake of magnesium and sulphur were significantly maximum (9.04kg ha^{-1} and 6.27kg ha^{-1}, respectively) observed in T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%). Whereas, T_7 were found significantly superior over all other treatments and T_{11} (control-water spray) has registered significantly minimum uptake of magnesium and sulphur (4.63kg ha^{-1} and2.66 kg $ha^{-1,}$ respectively).

The results of analyzed data, with respect to micronutrients were found to be statistically significant are given in Table 1 AND 2. Among different treatments, the results clearly showed that the uptake of zinc was significantly maximum (19.69g ha^{-1}) recorded in T_8 (K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%), which was on par (19.68g ha^{-1}) recorded in

T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%). Whereas, in T_{11} (control-water spray) was recorded maximum uptake of zinc (11.50g ha^{-1}).

Significant differences was observed with respect to uptake of boron (58.80g ha^{-1}) in T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%), which was on par (58.04g ha^{-1}) with T_8 (K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%), (56.29 g ha^{-1}) with T_3 (Borax at 0.25%) and (53.55g ha^{-1}) with T_9 (K_2SO_4 at 1% + Borax at 0.50% + $ZnSO_4$ at 0.50%). Whereas, the minimum uptake of iron (37.44g ha^{-1}) was observed in T_{11} (control-water spray).

The results of analyzed data, pertaining to uptake of copper (4.11g ha^{-1}) was found to be statistically significant in the treatment T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%), which was on par (23.91g ha^{-1}) with T_5 ($ZnSO_4$ at 0.25%). Whereas, the minimum uptake of copper (1.97g ha^{-1}) was observed in T_{11} (Control-water spray).

The data obtained on uptake of manganese was found to be significantly maximum (26.07g ha^{-1}) observed in T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%), which was on par (24.98g ha^{-1}) with T_5 ($ZnSO_4$ at 0.25%), (24.36g ha^{-1}) with T_8 (K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%). Whereas, in T_{11} (control-water spray) observed minimum uptake of manganese (19.16g ha^{-1}).

Significant differences was observed with respect to uptake of iron (72.71g ha^{-1}) recorded in T_7 (K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%). Whereas, the minimum uptake of iron (48.72g ha^{-1}) was observed in T_{11} (control-water spray).

The increase in uptake of macro and micro nutrients in petiole is might be due to the increase in photosynthetic activity and respiration of plants as influenced by zinc and boron. Zinc helps in metabolism of nitrogen and synthesis of auxin in the plant promotes cell division and cell enlargement as well as enhance the plant growth and development it leads to the more uptakes of macro and micro nutrients (Modi *et al.*, 2012) [12] and this also might be due to zinc regulates starch metabolism and acts as co-factor for many enzymes, affects photosynthesis reaction, nucleic acid metabolism and protein biosynthesis, thereby positively contributing it increased tissue growth and development will leads to more uptake of nutrients (Khan *et al.*, 2009) [7]. Similar results were reported by Yadav *et al.* (2017) and Singh *et al.* (2010) [18].

Table 1: Effect of foliar spray of potassium and micronutrients on petiole macronutrients content of Papaya *cv.* Red Lady.

Treatments	Treatment Details	Macronutrients					
		Primary			Secondary		
		Nitrogen (%)	Phosphorus (%)	Potassium (%)	Calcium (%)	Magnesium (%)	Sulphur (%)
T_1	K_2SO_4 at 1%	1.28	0.18	3.12	1.32	0.51	0.32
T_2	K_2SO_4 at 2%	1.30	0.19	3.18	1.15	0.44	0.35
T_3	Borax at 0.25%	1.27	0.18	2.88	1.35	0.53	0.27
T_4	Borax at 0.50%	1.26	0.17	2.84	1.25	0.48	0.28
T_5	$ZnSO_4$ at 0.25%	1.32	0.20	2.92	1.38	0.55	0.30
T_6	$ZnSO_4$ at 0.50%	1.31	0.20	2.96	1.30	0.50	0.32
T_7	K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%	1.33	0.20	3.35	1.45	0.62	0.43
T_8	K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%	1.29	0.19	3.26	1.43	0.59	0.40
T_9	K_2SO_4 at 1% + Borax at 0.50% + $ZnSO_4$ at 0.50%	1.29	0.19	3.20	1.21	0.47	0.37
T_{10}	K_2SO_4 at 2% + Borax at 0.50% + $ZnSO_4$ at 0.50%	1.28	0.17	3.15	1.18	0.46	0.35
T_{11}	Control (water spray).	1.25	0.17	2.75	1.10	0.40	0.23
S.Em±		0.01	0.01	0.01	0.01	0.01	0.01
C.D @ 5%		0.04	0.02	0.04	0.04	0.02	0.02

Table 2: Effect of foliar spray of potassium and micronutrients on petiole micronutrients content of Papaya *cv.* Red Lady.

Treatments	Treatment Details	Micronutrients				
		Zinc (ppm)	Copper (ppm)	Manganese (ppm)	Iron (ppm)	Boron (ppm)
T_1	K_2SO_4 at 1%	10.83	2.55	16.99	41.00	33.33
T_2	K_2SO_4 at 2%	11.80	2.70	17.42	45.53	36.67
T_3	Borax at 0.25%	10.30	2.47	15.80	47.80	41.33
T_4	Borax at 0.50%	11.20	2.45	15.48	45.23	42.00
T_5	$ZnSO_4$ at 0.25%	13.20	2.80	17.87	48.10	33.33
T_6	$ZnSO_4$ at 0.50%	13.83	2.73	17.66	47.60	34.67
T_7	K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%	13.50	2.82	17.88	49.87	40.33
T_8	K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%	13.80	2.62	17.07	44.23	40.67
T_9	K_2SO_4 at 1% + Borax at 0.50% + $ZnSO_4$ at 0.50%	14.17	2.60	17.12	43.27	42.33
T_{10}	K_2SO_4 at 2% + Borax at 0.50% + $ZnSO_4$ at 0.50%	14.07	2.52	16.88	43.53	42.67
T_{11}	Control (water spray).	9.93	2.41	16.55	40.07	32.33
S.Em±		0.42	0.08	0.05	1.72	1.40
C.D @ 5%		1.42	0.27	0.18	4.95	4.12

Table 3: Effect of foliar spray of potassium and micronutrients on petiole uptake of macronutrients of Papaya *cv.* Red Lady.

Treatments	Treatment Details	Macronutrients					
		Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Calcium (kg ha^{-1})	Magnesium (kg ha^{-1})	Sulphur (kg ha^{-1})
T_1	K_2SO_4 at 1%	17.11	2.41	41.71	17.65	6.82	4.28
T_2	K_2SO_4 at 2%	15.91	2.33	38.92	14.08	5.39	4.28

T_3	Borax at 0.25%	17.30	2.45	39.23	18.39	7.22	3.68
T_4	Borax at 0.50%	16.27	2.19	36.66	16.14	6.20	3.61
T_5	$ZnSO_4$ at 0.25%	18.45	2.80	40.82	19.29	7.69	4.19
T_6	$ZnSO_4$ at 0.50%	17.10	2.61	38.63	16.97	6.53	4.18
T_7	K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%	19.39	2.92	48.84	21.14	9.04	6.27
T_8	K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%	18.41	2.71	46.52	20.41	8.42	5.71
T_9	K_2SO_4 at 1% + Borax at 0.50% + $ZnSO_4$ at 0.50%	16.32	2.40	40.48	15.31	5.95	4.68
T_{10}	K_2SO_4 at 2% + Borax at 0.50% + $ZnSO_4$ at 0.50%	15.88	2.11	39.09	14.64	5.71	4.34
T_{11}	Control (water spray)	14.48	1.97	31.85	12.74	4.63	2.66
S.Em±		0.42	0.07	1.01	0.72	0.15	0.13
C.D @ 5%		1.35	0.21	3.12	2.13	0.45	0.41

Table 4: Effect of foliar spray of potassium and micronutrients on petiole uptake of micronutrients of Papaya *cv.* Red Lady.

Treatments	Treatment Details	Micronutrients				
		Zinc (g ha^{-1})	Copper (g ha^{-1})	Manganese (g ha^{-1})	Iron (g ha^{-1})	Boron (g ha^{-1})
T_1	K_2SO_4 at 1%	14.48	3.41	22.72	54.82	44.56
T_2	K_2SO_4 at 2%	14.44	3.30	21.32	55.73	44.88
T_3	Borax at 0.25%	14.03	3.36	21.52	65.10	56.29
T_4	Borax at 0.50%	14.46	3.16	19.98	58.39	54.22
T_5	$ZnSO_4$ at 0.25%	18.45	3.91	24.98	67.24	46.60
T_6	$ZnSO_4$ at 0.50%	18.05	3.56	23.05	62.12	45.24
T_7	K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25%	19.68	4.11	26.07	72.71	58.80
T_8	K_2SO_4 at 2% + Borax at 0.25% + $ZnSO_4$ at 0.25%	19.69	3.74	24.36	63.12	58.04
T_9	K_2SO_4 at 1% + Borax at 0.50% + $ZnSO_4$ at 0.50%	17.93	3.29	21.66	54.74	53.55
T_{10}	K_2SO_4 at 2% + Borax at 0.50% + $ZnSO_4$ at 0.50%	17.46	3.13	20.95	54.02	52.95
T_{11}	Control (water spray).	11.50	2.79	19.16	48.72	37.44
S.Em±		0.43	0.10	0.07	1.56	1.76
C.D @ 5%		1.21	0.30	2.13	5.12	5.65

Conclusion

From the present investigation results were revealed that foliar application is an instant effective way of application of nutrients. Plants sprayed with K_2SO_4 at 1% + Borax at 0.25% + $ZnSO_4$ at 0.25% significantly increased nutrient content (petiole analysis) and uptake in petiole of papaya *cv.* Red Lady.

References

1. Anonymous. State wise area, production and productivity of papaya. National Horticulture Board, Indian Horticulture Database-2018-19.
2. Cakmak I. Enrichment or cereal grain with zinc: agronomic or genetic biofertification. Pl. Soil. 2008;302:1-17.
3. Chan Jr. HT, Chang TSK, Stafford AE, Brekke JE. Non volatile acids in papaya. J Agri. Food. Chem. 1971;19(2):263-265.
4. Fernandez V, Sotiropoulos T, Brown PH. Foliar fertilization. In: Scientific Principles and Field Practices. International Fertilizer Industry Association, Paris, 2013.
5. Ganeshamurthy N, Satisha GC, Patil P. Potassium nutrition on yield and quality of fruit crops with special emphasis on banana and grapes. Karnataka J Agric. Sci. 2011;24(1):29-38.
6. Geraldson CM. Potassium nutrition of vegetable crops. In Munson, R.D. (Ed) Potassium in Agriculture, Madison, W. I. 1985;94(1):915-927.
7. Khan S, Singh HK, Vishwanath, Pratap B. Impact of foliar application of micro-nutrients and thiourea on growth, fruit yield and quality of aonla (*Emblica officinalis* Gaertn) cv. Narendra Aonla-6. Annals of Hort. 2009;2(1):83-85.
8. Kumar M, Swarup A, Patra AK, Chandrakala JU. Micronutrient fertilization under rising atmospheric CO_2 for micronutrient security in India. Ind. J Ferti. 2011;7(7):52-60.
9. Lester GE, Jifon JL, Makus DJ. Impact of potassium nutrition on postharvest fruit quality: Melon (*Cucumis melo* L.) case study. Plant Soil. 2010;335:117-131.
10. Marschner H. Functions of mineral nutrients: macronutrients, In: H. Marschner (Ed.). Mineral nutrition of higher plants 2nd Edition. Academic Press, N. Y. 1995;94(1):299-312.
11. Marschner H. Mineral Nutrition of Higher Plants. Academic Press Limited Harcourt Brace and Company, Publishers, London, 2012, pp. 347-364.
12. Modi PK, Varma LR, Bhalerao PP, Verma P, Khade A. Micronutrient sprays effects on growth, yield and quality of papaya (*Carica papaya* L.) *cv.* Madhu Bindu. Madras Agric. J. 2012;99(7/9):500-502.
13. Panse VG, Sukhatme PV. Statistical method of Agricultural workers, ICAR Publication. New Delhi, 1967, pp. 381.
14. Parmar P, Patil SJ, Kumar S, Asha CM, Tandel BM. Response of fertilizer application on growth of papaya var. Red Lady. Int. J Curr. Microbiol. App. Sci. 2017;6(12):2375-2379.
15. Reddy YTN, Kurian RM, Ganeshamurthy AN, Pannerselvam P. Effect of organic nutrition practices on papaya (*cv.* Surya) fruit yield, quality and soil health. J. Hortic. Sci. 2010;5(2):124-127.
16. Sajid M, Abdur-Rab, Ali N, Arif M. Effect of foliar application of Zn and B on fruit production and physiological disorders in sweet orange cv. Blood Orange. Sarhad J Agric. 2010;26(3):355-360.
17. Sing DK, Paul PK, Ghosh SK. Response of papaya to foliar application of boron, zinc and their combination. Dept. Pomology & Post harvest Technol. Uttar Banga Krishi Viswavidyalaya, Pundibari-736 165, Cooch Behar

(West Bengal), India, 2002.
18. Singh DK, Ghosh SK, Paul PK, Suresh CP. Effect of different micronutrients on growth, yield and quality of papaya (*Carica papaya* L.) cv. Ranchi. Acta Hort. 2010;851:351-356.
19. Singh ID. Papaya, New Delhi, India: Oxford and IBH Publishing company private Ltd, 1990.
20. Singh S, Ahlawat VP. Physico-chemical attributes and mineral composition of ber leaves as affected by foliar application of urea and zinc sulphate. Haryana J Hortic., Sci. 1995;24:94-97.