International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 9, Issue 26, 2017, pp.-4331-4334.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

INFLUENCE OF MICRONUTRIENTS ON FLOWERING PARAMETERS AND FRUIT CHARACTERS OF SAPOTA *cv.* KALIPATTI UNDER HDP SYSTEM

GUVVALI THIRUPATHAIAH[1*], SHIROL A. M.[2], SAMPATH P. M.[3], NAIK NAGESH[4], BHASKAR RAO B.[5] AND NIRMALA A.[6]

[1,3,4]Department of Fruit Science, Kittur Rani Channamma College of Horticulture, Arabhavi, 591218, University of Horticultural Sciences, Bagalkot, Karnataka, 587104
[2]Department of Horticulture AICRP (Fruits), KRC College of Horticulture, Arabhavi, 591218, University of Horticultural Sciences, Bagalkot, Karnataka, 587104
[5]Department of Fruit Science, Sri Konda Laxman Telangana State Horticultural University, Budwel, Hyderabad, Telangana, 500030
[6]Department of Floriculture and Landscaping, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana, 500030
*Corresponding Author: Email-thiruicar@gmail.com

Received: April 29, 2017; Revised: May 15, 2017; Accepted: May 16, 2017; Published: June 06, 2017

Abstract- The field experiment was carried out to know the response of soil and foliar application of micronutrients (i.e., zinc, iron and boron) on flowering and fruit characters of sapota *cv.* Kalipatti under HDP system at Kittur Rani Chennamma College of Horticulture, Arabhavi during 2015-2016. Zinc and iron sulphates are used for soil and foliar application, boron for soil application sodium tetraborate (Jai bore) and for the foliar application solubor were used. The results indicated that the foliar application T10 -RDF + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 0.3% B per tree (i.e. in two times as foliar i.e. 1st at 50 per cent flowering and another at fruits at pea size) was shown reduced number of days (29 days) for flower initiation, flower opening fruit set (29.50 days), days taken to reach harvesting stage (195 days), maximum number of flowers ((16.95) and fruits (2.90) per shoot and the highest per cent fruit set (23.03%) and fruit retained (85.61%) at harvesting stage were noticed. Also it gave superior fruit characters like fruit weight (111.33 g), fruit length (6.06cm), fruit girth (5.78cm) and fruit volume (100.50ml) were noticed where as the lowest values was noticed in control (T1), and water spray (T2).

Keywords- Flowering, Micronutrients and Fruit Quality.

Citation: Guvvali Thirupathaiah, et al., (2017) Influence of Micronutrients on Flowering Parameters and Fruit Characters of Sapota *cv.* Kalipatti under HDP System. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 9, Issue 26, pp.-4331-4334.

Academic Editor / Reviewer: Anil Sabarad

Introduction

Kalipatti is one of the popular varieties around Bangalore and Northern Districts of Karnataka. This variety is known for its prolific yield and high sugar content. Kalipatti on an average takes 62 days from flower initiation to flower opening. It bears 8-10 flowers per shoot during its peak flowering periods *i.e.,* November-December and February-April. Though, the per cent of flowering (72.72 %) it has the tendency of low fruit set (12-20%). The fruits are round or oval shaped, weighing 67.80 g on an average and medium in size with 4.70 cm length and 4.96 cm diameter [1].The successful commercial cultivation of this crop is depend on many factors such as climate, soil, irrigation, fertilizer, spacing and season of growing etc. Among the different management practices, nutrient management plays an important role in growth, yield and quality fruits under high density planting (HDP) system. To perform sustainable yield and quality it need high amount of nutrients [2]. The intensive and exploitative agriculture with high inputs and high yielding varieties and improved technologies which was helped better fruit production. But under high density planting competition for water and nutrients and the major nutrients usually supplied through straight fertilizers or mixture in an aggressive manner it lead to the depletion of micronutrients by maximum utilization it will ultimately resulting to the indeed application of micronutrients. To sustain the production of fruit crops maintenance of micro and secondary nutrients becomes very pertinent to foresee the emerging nutrient deficiencies and to evolve suitable ameliorating technologies. Present days, the major nutrients are usually supplied through straight fertilizers or mixed fertilizers to enhance the yield of sapota and it will results in depletion of micronutrients.

Sapota has the problem of low fruit setting and shedding of fruits. Only about 10-12 per cent of the total fruits set, and retains until maturity. Maximum fruit-drop occurs immediately after fruit setting. Increase in fruit set and retention is possible by spraying of boron (B), Iron (Fe) promotes formation of chlorophyll pigments, which will acts as an oxygen carrier and reactions involving cell division and growth. Zinc (Zn) aids in regulating plant growth hormones and enzyme system, necessary for chlorophyll production, carbohydrate and starch formation. Zinc is an important for the formation and activity of chlorophyll and in the functioning of several enzymes and the growth hormone, auxin [3]. Therefore, based on the possible benefits of micro nutrients, the present study was carried out to know the effect of soil and foliar application of micro nutrients on flowering parameters and fruit characters of sapota *cv.* Kalipatti under HDP system.

Materials and Methods

Experimental details

Field experiments were conducted at Kittur Rani Chennamma College of Horticulture, Arabhavi, Belagavi District during 2015-2016, the plants were selected are uniform in size and planted with a spacing of 3×3 m. Experiments were laid out in Randomized Complete Block Design with eleven treatments *viz.,* T1: control-only recommended dose of fertilizers [RDF], T2: water foliar application + RDF, T3: $ZnSO_4$ (50 g/plant soil application)+RDF, T4: $FeSO_4$ (40 g/plant soil application)+RDF, T5: Boron (Jai bore 25 g/plant soil application)+RDF, T6: $ZnSO_4$ (foliar application 0.5 per cent)+RDF, T7: $FeSO_4$ (foliar application 0.5 per cent) +RDF, T8: boron (Solubor for foliar application 0.3 percent)+RDF, T9: $ZnSO_4$ (50 g) + $FeSO_4$ (40 g) + boron (25 g) for soil application+ RDF. T10: $ZnSO_4$ (0.5%) + $FeSO_4$ (0.5%) + boron (0.3%) for foliar application+ RDF. Micronutrients (foliar application) and T11: T9 +T10+RDF. These nutrients are applied in two times as foliar i.e. 1st at 50 per cent flowering and another at fruits at pea size. For soil application micronutrients applied along with RDF. It was recorded by manual counting the flowers on newly emerged shoots in four direction of plant and in each direction five shoots has tagged. It was recorded by counting calendar days from flower initiation to fruit set *i.e.,* pea size fruits.

Statistical analysis of experimental data

The experimental data collected relating to different parameters were statistically analyzed as described by [4] and the results were tested at 5 per cent level of significance by Fischer method of analysis of variance.

Results and Discussion

The effect of micronutrients on flowering parameters of sapota.

Number of days taken for flower initiation

The minimum number of days for flower initiation noticed in T4 (28) and T10 (29.83) and the maximum number of days (37.67) in T2 and T1 [Table-1]. This is due Zn, Fe and boron play major role in N and S metabolism, chlorophyll synthesis these metabolic activities may helps in production of good amount of biomass that leads to early flower initiation [5]. Zinc enhanced the synthesis of auxin in the plants. Iron is credited with a definite role in the synthesis of chlorophyll molecules. Similarly, boron regulates metabolism and translocation of carbohydrates, cell wall development and RNA synthesis [6]. The combined effect of Zn, Fe and B has played a vital role in increase of physiological activities leading to early initiation of flowering [7].

Number of flowers per shoot

The maximum number of flowers (16.95) was recorded in T8 (foliar application of boron 0.3%), T10 (foliar spray of 0.5% ZnSO4 + 0.5% FeSO4 + 0.3% B per tree.) (16.81), T4 (Soil application of 40 g FeSO4 per tree) (16.67), T6 (Foliar spray of 0.5% ZnSO4 per tree) (16.50) and T5 (Soil application of 25 g B per tree) (14.33), and the minimum number of flowers or flower buds (9.67) was recorded in T1 and in T2 [Table-1] and [Fig-1].

It is because boron play important role in sugar translocation. It will helps in flower production, Fe play major role in N and S metabolism, chlorophyll synthesis these metabolic activities may helps in production of good amount of biomass it helps in increased number of flower production and zinc (Zn) essential for auxin synthesis it helps in high number of flower production. This might be due to adequate amount of boron present in foliage which is used for development and growth of new cell in the plant meristem [8].

Number of fruits per shoot

The maximum number of fruits (2.90 fruits/shoot) was recorded in the treatment T10 (Foliar spray of 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 0.3% B per tree.) which was significance with T4 (2.67), followed by T8 (2.45), minimum number of fruits per shoot (0.66) was recorded in T11 (T9+T10) [Table-1] and [Fig-1].This might have resulted into better photosynthesis, greater accumulation of starch in fruits and the zinc involvement in auxin synthesis and boron in translocation of starch from source to sink (fruits). The balance of auxin in plant regulates the fruit drop or retention in plants, which will helps in control of fruit drop and increased the total number of fruits per tree [9-13]. The reduce number of fruits was due to high concentration of Zn and Fe, low concentration of boron.

Per cent fruit set and per cent fruits reached to final harvest

The soil and foliar application of micronutrients had significant influence on Per cent fruit set [Table-1] and [Fig-2]. The results reveal that maximum fruit set was recorded in T10 (23.03 %) which was on par with T5 (21.46) which is might be due to the combine application and boron has play major role in pollen germination and sugars translocation results in increased fruit set [14-18]. The soil and foliar application of micronutrients has significant influence on per cent fruits reached to final harvest [Table-1] and [Fig-2]. The results reveal that maximum number of fruits retained at final harvest (85.61 %) was recorded in T10 which was on par with T6 (77.92%) this may be due to the zinc play important role in auxin synthesis which will helps in fruit retention [19-23].

Number of days taken to flowering to fruit set and flowering to fruit harvest

The results found that, the minimum days taken for fruit set T10, and T8 (29.5) which was on par with T6 and T9 (29.67 and 30.00) which might be due to micronutrients play an essential role in the nitrogen metabolism and promotes the enzymatic activity in the cell wall [Table-1]. The earliness in flowering was attributed to encourage the fertilizing process of plants and also enhance the premature rapture of pollen tubes and thus to promotes their growth and whole process of pollination [24]. The maximum days taken with T1 (32.00) in control. It was found that zinc enhanced the synthesis of auxin and iron is credited with a definite role in the synthesis of chlorophyll molecules. Similarly, boron regulates metabolism and translocation of carbohydrates, cell wall development and RNA synthesis. The combined effect of different micronutrients might have played a vital role in increasing of physiological activities leading to early fruit set in sapota *cv.* Kalipatti. In the present study number of days to flower opening to harvesting has shown significant different among the different treatments [Table-1] & [Fig-3]. The results reveals that the significance reduced crop cycle days with T7 (183.5) followed by T4 (191.40) which is on par with T8, T5, and T3 (191.40, 193.67 and 194.00) and the maximum number of days taken with T2 (221.00). This might have resulted into better photosynthesis, greater accumulation of starch in fruits by increasing the amount of chlorophyll and with zinc involved in auxin synthesis and boron helps in translocation of starch to fruits and also boron regulates metabolism and translocation of carbohydrates, cell wall development and RNA synthesis [25] and these metabolic activities helps to early crop maturation.

Table-1 *Effect of micronutrients on flowering parameters of sapota.*

Treatments	Flowering parameters						
	A	B	C	D	E	F	G
T1- Control (RDF)	37.67	9.67	1.02	32.00	220.07	16.52	60.00
T2- RDF + Water spray	37.67	9.67	0.99	31.00	221.00	17.41	62.00
T3- RDF + 50 g ZnSO4 per tree (SA)	33.83	11.00	1.33	30.33	194.00	9.83	71.90
T4- RDF + 40 g FeSO4 per tree (SA)	28.00	16.67	2.67	31.00	191.40	19.87	70.83
T5- RDF + 25 g B per tree (SA)	35.00	14.33	2.00	31.67	193.67	21.46	74.74
T6- RDF + 0.5% ZnSO4 per tree (FA)	34.33	16.50	1.84	29.67	209.13	18.07	77.92
T7- RDF + 0.5% FeSO4 per tree (FA)	34.67	12.50	1.95	32.50	183.50	16.63	63.16
T8- RDF + 0.3% B per tree (FA)	36.00	16.95	2.45	29.50	191.50	17.16	74.82
T9- RDF + 50 g ZnSO4+40 g FeSO4+ 25 g B per tree (SA)	32.00	10.00	1.01	30.00	204.55	14.21	56.68
T10- RDF + 0.5% ZnSO4 + 0.5% FeSO4 + 0.3% B per tree (FA)	29.83	16.81	2.90	29.50	195.50	23.03	85.61
T11- T9 + T10	31.53	11.00	0.66	32.00	220.33	8.33	50.00
S. Em ±	**0.23**	**0.88**	**0.05**	**0.24**	**1.16**	**0.66**	**3.36**
C. D. at 5%	**0.67**	**2.59**	**0.14**	**0.71**	**3.43**	**1.95**	**9.93**

A: Days taken to flower initiation, B: No. of flowers/shoot, C: No. of fruits/ shoot, D: Days taken to flower opening to fruit set, E: Days taken to flower opening to harvest, F: Percent fruit set G: Per cent fruits retained at final harvest

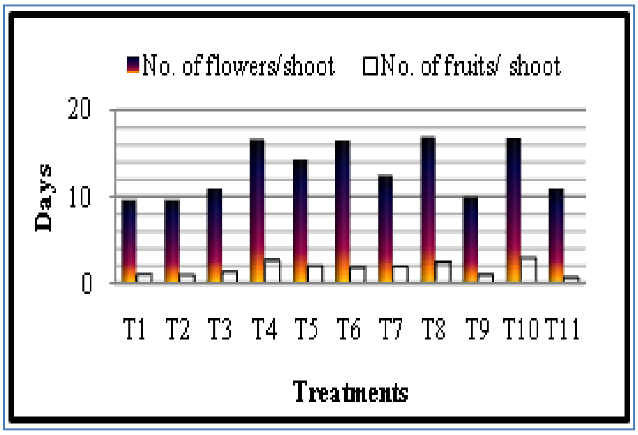

Fig-1 Effect of micronutrients on number of flowers and fruits of sapota.

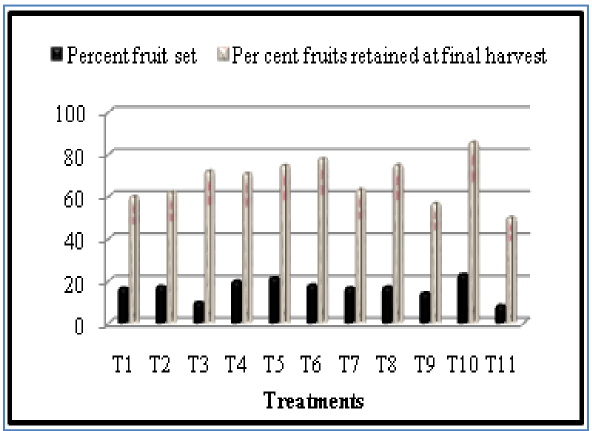

Fig-2 Effect of micronutrients on fruit set and fruit retention of sapota.

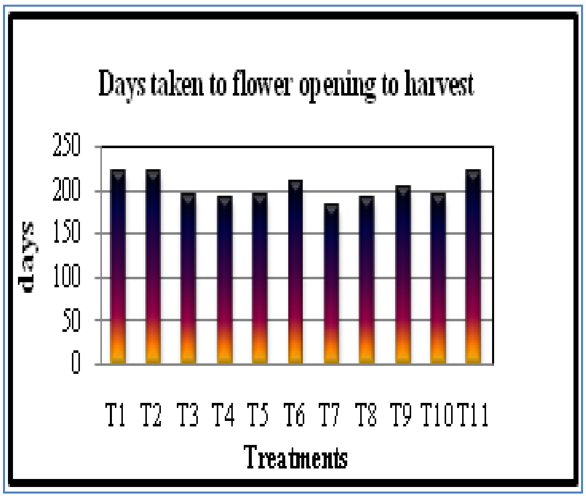

Fig-3 Effect of micronutrients on number of days to harvesting of sapota.

T1- Control (RDF) ;**T2**- RDF + Water spray ;**T3**- RDF + 50 g ZnSO4 per tree (SA)
T4- RDF + 40 g FeSO4 per tree (SA) ;**T5**- RDF + 25 g B per tree (SA) ;**T6**- RDF + 0.5% ZnSO4 per tree (FA)
T7- RDF + 0.5% FeSO4 per tree (FA) ;**T8**- RDF + 0.3% B per tree (FA) ;**T9**- RDF + 50 g ZnSO4+40 g FeSO4+ 25 g B per tree (SA)
T10- RDF + 0.5% ZnSO4 + 0.5% FeSO4 + 0.3% B per tree (FA) ;**T11**- T9 + T10

The effect of micronutrients on fruit characters of sapota.

The results of observations recorded on fruit characters *viz.*, fruit weight (g), fruit length (cm), fruit girth (cm) and fruit volume(ml) due to the effect of soil application and foliar spray of micronutrients during the crop growth are discussed [Table-2] and [Plate-1]. The maximum fruit weight (111.33 g) was recorded in treatment T10 (foliar spray of $ZnSO_4$ (0.5%) + $FeSO_4$ (0.5%) + B (0.3%) per tree). However, the lowest fruit weight recorded in T2 (81.13 g) and T11 (81.67 g).The maximum fruit length (6.263 cm) was recorded in treatment T9 which was statistically on par with treatments T6 (6.150 cm), T10 (6087 mm), T8 (6.060 cm), T4 (6.053 cm), T5 (6.013 cm), T7 (5990 cm). The minimum fruit length (5.527 cm) was recorded in T11 (T9+T10). The maximum fruit diameter (5.785 cm) was recorded in the treatment T10 (Foliar spray of ZnSO4 (0.5%) + FeSO4 (0.5%) + B (0.3%) per tree.) which was on par with treatments, T8 (5.750 cm), T5 (5.699 cm). However, treatment T6 recorded the minimum diameter of fruit (4.647 cm). The maximum volume of fruit (100.50 ml) the minimum volume of fruit (81.33 ml) was recorded in treatment T11. The increase in fruit weight in mango with the spray of borax was might be due to the involvement in harmonal metabolism, increase in cell division and expansion of cell. Boron is also known to stimulate rapid mobilization of water and sugar in the fruit and zinc play role in tryptophan metabolism and iron is essential for the chlorophyll synthesis. Ferritin, which stores and releases Fe, makes up about 75 % of the content of chloroplasts in leaf cells. Moreover, iron participates in the electron transport in the process of reduction *via* cytochromes and ferredoxin [26-30]. The decreased fruit weight, length and volume in T11 due higher concentration of micronutrients and in T6 decreased fruit weight, girth and volume due to toxic effect of Zn at 0.5% foliar spray it had shown adverse effect on boron. The boron regulates metabolism and translocation of carbohydrates, cell wall development and RNA synthesis [31].

.**Table-2** *Effect of micronutrients on fruit characters of sapota.*

Treatments	Fruit characters			
	Fruit weight (g)	Fruit girth(cm)	Fruit length (cm)	Volume of fruit (ml)
T1- Control (RDF)	88.83	4.95	5.86	85.53
T2- RDF + Water spray	81.13	5.01	5.62	85.50
T3- RDF + 50 g ZnSO4 per tree (SA)	80.53	4.98	5.55	86.33
T4- RDF + 40 g FeSO4 per tree (SA)	101.47	5.63	6.05	99.00
T5- RDF + 25 g B per tree (SA)	109.33	5.69	6.01	99.33
T6- RDF + 0.5% ZnSO4 per tree (FA)	60.00	4.64	6.15	80.33
T7- RDF + 0.5% FeSO4 per tree (FA)	89.47	5.02	5.99	89.50
T8- RDF + 0.3% B per tree (FA)	100.00	5.75	6.06	99.50
T9- RDF + 50 g ZnSO4+40 g FeSO4+ 25 g B per tree (SA)	88.00	5.32	6.26	97.00
T10- RDF + 0.5% ZnSO4 + 0.5% FeSO4 + 0.3% B per tree (FA)	111.33	5.78	6.08	100.50
T11- T9 + T10	81.67	5.04	5.52	81.33
S. Em ±	**0.48**	**0.22**	**0.27**	**0.45**
C. D. at 5%	**1.41**	**0.64**	**0.80**	**1.33**

T_1-Control

T_{6}- RDF + 0.5% $ZnSO_4$ per tree (Foliar application)

T_{10}- RDF + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 0.3% B per tree (Foliar application)

Plate-1 Fruits of sapota with micronutrients application

Conclusion

From this study it can be concluded that T10 -RDF + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 0.3% B per tree foliar application can be recommended for getting early flowering and harvesting with an increased fruit set, fruit retention along with good frit size and appearance. It will also promote early market availability there by the produce get good price, these increased fruit characters greatly promote the yield and quality attributes of sapota.

Acknowledgement

The authors are highly acknowledged in Research Services, Mr. A. M. Shirol, Chairman of my Advisory Committee, Assoc. Prof of Horticulture, AICRP (Fruits) K.R.C.C.H, Arabhavi, for his exemplary guidance, valuable feedback, and constant encouragement throughout the duration of the research, his valuable suggestions were of immense help throughout my research work. Sampath, Nagesh Naik, Bhaskar Rao and Nirmala's generous, splendid and precious guidance till last minute helped me in completing this task with edifying counsel, constructive suggestions, necessary guidance and advice, was able to complete my investigation successfully.

Author Contributions: All author equally contributed

Abbreviations: HDP - High Density Planting

Conflict of Interest: None declared

References

[1] Lenka P. C., Das D. K. and Samal B. (1996) *Orissa J. Hort.,* 24(1-2), 41-46.
[2] Mishra D. (2014) *J. Agri. Crop Sci.,* **1**, 36-38.
[3] Jeyakumar P. and Balamohan T. N. (2013) Micronutrients for horticultural crops. (http://agritech.tnau.ac.in).
[4] Sundar R. N., Nagaraj S., Venkataramu M. N. and Jagannath M. K. (1972) *Univ. Agric. Sci.,* pp. 106-110.
[5] Elcio F.d.S., Bruno J.Z., Aline G. D. C. and Raphael (2013) *Rev. Bras. Cenic Solo.,* 37, 1334-1342.
[6] Ram R. A. and Bose T. K. (2000) *Indian J. Hort.,* 57(3), 215-220.
[7] Tulsi D., Gurjar N. L. P., Bhakti P. and Darshana C. (2015) *The Bioscan.,* 10(3), 1053-1056.
[8] Rashid A., Yasin M., Ashraf M. and Mann R.A. (2004) *Int. Rice Res. notes,* 29, 58-60.
[9] Dutta P. (2004) *Indian J. Hort.,* 61(3), 265-266.
[10] Jeyabaskaran K. J. and Pandey S. D. (2008) *Indian J. Hort.,* 65(1), 102-105.
[11] Kavitha M., Kumar N. and Jeyakumar P. (2000) *South Indian Hort.,* 48(1-6), 1-5.
[12] Sarolia D. K., Rathore N. S. and Rathore R. S. (2007) *Curr. Agri.,* 31(1-2), 73-77.
[13] Singh J. and Maurya A. N. (2003) *Prog. Agri.,* 4(1), 47-50.
[14] Ahmad S. K., Waseem U., Aman U. M., Rashid A., Basharat A. S. and Ishtiaq A. R. (2012) *Pak. J. Agri. Sci.,* 49(2), 113-119.
[15] Callan N. W., Thompson M. M. and Chaplin M. H. (1978) *J. American Soc. Hort. Sci.*, 103, 7.
[16] Gurjar M. K., Kaushik R. A. and Prerna B. (2015) *Int. J. Sci. R.,* 4 (4), 2277 – 8179.
[17] Rajput C. B. S. and Ram M. (1979) Res. Rep. Mango Workers Meeting, Panayi, Goa., 179p. 69.
[18] Shivanandam V. N., Pradeep S. L., Rajanna K. M. and Sivappa (2007) *J. Soils & Crops.,* 17(2), 225-229.
[19] Lenny W. M. and Patrick J. C. (2008) *Hort. Sci.,* 43(3), 696–699.
[20] Nilesh B. and A. R. Banik A. R. (2011) *Indian J. Hort.,* 68(1), 103-107.
[21] Rajput C.B.S., Singh B.P. and Singh S.B. (1976) *Bangladesh Hort.,* 4(2), 23-24.
[22] Vikas Y., Singh P.N. and Prakash Y. (2013) *Int. J. Sci. Res. Publ.,* 3(8), 2250-3153.
[23] Yadav V., Singh P. N. and Yadav P. (2013) *Int. J. Scient. Res. Publ.,* 3(8), 1-6.
[24] Ramesh C. and Singh K. K. (2015) *J. Med. P. Studies,* 3(5), 42-45
[25] Banik B. C. and Sen S. K. (1997) *Hort. J.,* 10(1), 23-29.
[26] Khayyat M., Tafazoli E., Eshghi S. and Rajaee S. (2007) *American-Eurasion J. Agric. Env. Sci.,* 2 (3), 289-296.
[27] Marschner H. (1986) Mineral nutrition of higher plants. Academic Press, London, 674.
[28] Rani R. and Brahmachari V. S. (2001) *Orissa. J. Hort.,* 29(1), 50-57.
[29] Razzaq K., Khan A. S., Malik A. U., Shahid M. and Ullah S. (2013) *J. Pl. Nutri.,* 36(10), 1479-1495.
[30] Saraswathy S., Balakrishnan K., Anbu S., Azhakia M R. S. and Thangaraj T. (2004) *South Indian Hort.,* 52(1-6), 41- 44.
[31] Malik N. J., Chamon A. S., Mondal M. D., Elahi S. F. and Faiz S. M. A. (2011) *J. Bangladesh young Res.,* 1(1), 79-91.