Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI:10.21474/IJAR01/7213
DOI URL: http://dx.doi.org/10.21474/IJAR01/7213

RESEARCH ARTICLE

INFLUENCE OF FOLIAR SPRAYS ON YIELD AND QUALITY OF BARAMASI LEMON.

Jobanjit Singh and Amarjeet Kaur.
Department of Horticulture(Agriculture)Khalsa College, Guru Nanak Dev University, Amritsar-143001.

Manuscript Info

Manuscript History

Received: 05 April 2018
Final Accepted: 07 May 2018
Published: June 2018

Keywords:-
Baramasi lemon, NAA, GA_3, KNO_3,Borax, Brix, Acidity, Foliar, Yield.

Abstract

The present study entitled **Influence of foliar sprays on yield and quality of baramasi lemon** was conducted in the well maintained citrus orchard of Department of Horticulture, Faculty of Agriculture, Khalsa College, Amritsar during 2017-2018. To improve the yield and quality of baramasi lemon foliar sprays of (NAA- 25,50 and 75 ppm, GA_3-15,20 and 25 ppm, Borax- 0.5, 1 and 1.5% and KNO_3- 1,1.5 and 2%) were applied at 70% flowering and at pea stage in treatments T_1 to T_{13}.Results of the study revealed that the maximum fruit length(5.95 cm), breadth (5.60 cm), fruit weight (68.86 g) and highest juice per cent (50.06) were recorded with GA_3 25 ppm. Among bio-chemical characters maximum TSS (7.85°Brix), acidity (5.80 %) and ascorbic acid content (54.21 mg/100ml juice were recorded in the fruits treated with GA_3 25 ppm. Results of the study also showed that significantly higher fruit yield (17.93 kg) was obtained from the plants treated with GA_3 25. Hence the foliar application of GA_3 25 increased the yield and improved the fruit quality of baramasi lemon.

Introduction:-

Citrus, also known as agrumes (sour fruits)is one of the world's major fruit crops with global availability and popularity contributing to human diet (Liu *et al* 2012). Among citrus, lemon (*Citrus limon.* Burm) belonging to the family Rutaceae probably originated in the eastern Himalayan region and foothills of India. It comes under the category of acid fruits and is used primarily as fresh fruits (Bhatt *et al* 2016). It is grown mainly in Andhra Pradesh, Uttar Pradesh, Gujarat, Assam and Punjab. Baramasi lemon is well adapted to agro-climatic conditions of Punjab and it bears crop twice a year i.e. July-August and January-February with a sparse flowering and fruiting throughout the year. Lemon fruits have high medicinal value and industrial use as it is a rich source of vitamin C with fair amounts of vitamin A, B and minerals such as calcium, phosphorus and iron (Khehra and Bal 2014). Besides their consumption as fresh fruit, a large number of products and by-products like pickles, squash, jam, jelly, candies and marmalades are prepared and marketed at a premium price (Ahmed *et al* 2007). The juice of ripe fruit is refreshing and is one of the best remedies for scurvy. Despite all these characters its cultivation has not been taken up on a commercial scale due to large fruit size, thick rind and high incidence of fruit cracking (Nawaz *et al* 2008).Plant growth regulators play a paramount role in citrus biology, increased production of quality fruits and can affect flowering, fruit setting, fruit development, fruit drop control, fruit shape and fruit size (Berhow 2000). Auxins act as stimulators of growth and also as abscission agents. Growth regulators (GA_3/NAA/2,4-D) when applied exogenously improve fruit set percentage and increase the average yield per plant (Nawaz *et al* 2008). Foliar sprays of plant growth regulators and nutrients not only improve the size but also enhances qualitative parameters.

Corresponding Author:-Jobanjit Singh.
Address:-Department of Horticulture(Agriculture)Khalsa College, Guru Nanak Dev University, Amritsar-143001.

Potassium nitrate (KNO_3) is known for the development of fruit, movement of sugars and enhances internal fruit quality (Debage *et al* 2011). Application of boron increases fruit set and yield by its role in pollen tube, germination and elongation and enhances juice content (Asad *et al* 2003). Therefore, for successful cultivation of baramasi lemon in the state, efficient management of foliar sprays is of utmost importance to produce high yield and quality fruits.

Materials And Methods:-

The present study entitled **Influence of foliar sprays on yield and quality of baramasi lemon** was conducted in the well maintained citrus orchard of Department of Horticulture, Faculty of Agriculture, Khalsa College, Amritsar during 2017-2018. The trial was conducted on uniform vigorous citrus trees growing at citrus orchard. On selected trees different concentrations of NAA, GA_3, borax and KNO_3 were sprayed at 70 % flowering and at pea stage. The fruits were harvested at proper stage of maturity. The orchard is located at north of the city and falls at 31-38' N latitude and 75-52' E latitude with an elevation of 744 feet above the sea level representing the climatic conditions prevailing in the sub-tropical humid zone of the Punjab state with an annual rainfall of 735 mm, the major portion of which falls from July to September. The soil of the orchard was well drained and fairly fertile with pH of 7.5.The experiment comprised of 13 treatments. The trial was replicated thrice according to the Randomised Block Design . A total number of 39 trees were ear marked for the experiment. All the selected trees were given uniform cultural practices as recommended by Punjab Agricultural University, Ludhiana. On the selected trees, three concentrations of each chemical(NAA- 25,50 and 75 ppm, GA_3-15,20 and 25 ppm, Borax- 0.5, 1 and 1.5% and KNO_3- 1,1.5 and 2%) were sprayed. The control treatment was confined to water spray. The chemicals were first dissolved in a little quantity of water and then the required volume was made by adding distilled water. The physico-chemical analysis was carried out in the laboratory of Department of Horticulture, Khalsacollege, Amritsar.

Results And Discussion:-

Fruit size (cm):-

Maximum fruit length (5.95 cm) and breadth (5.60 cm) were recorded in the fruits harvested from plants treated with GA_3 25. Minimum fruit length (4.75 cm) and breadth (4.40 cm) were under control. Fruit elongation and increase in fruit breadth might be due to cell division initially, and cell enlargement in the later stages. Similar findings have been documented by Singh *et al* (2007) and Bhatia and Yadav (2005). The other possible reason for enhancement of fruit size with NAA and GA_3 might be due to their involvement in hormonal metabolism, increased cell division, elongation and expansion of cells. Nawaz *et al* (2011) observed maximum fruit size with the application of GA_3 10 ppm in kinnow mandarin and Debaje *et al* (2011) have also observed increased fruit size in acid lime with the application of KNO_3 2 % + GA_3 100 ppm. The above results revealed that the increase in fruit length might be due to ability of gibberellic acid to increase cell enlargement, thus enhancing fruit growth. Similar results were reported by Jagtap*et al* (2013) in kagzi lime, Shinde*et al* (2008), Kachave and Bhosale (2007) in acid lime, Yadav and Chaturvedi (2004) in ber, Dixit *et al* (2013) in litchi and Gaur *et al* (2014) in guava.

Fruit weight (g):-

The maximum fruit weight (68.86 g) was recorded in the fruits harvested from the plants treated with$GA_3$25ppm. All the treatments significantly increased the fruit weight as compared to control with (52.73g) fruit weight respectively. The results are in confirmity with the findings of EI-Agamy *et al* (2004) in acid lime and Saleem*et al* (2008) in blood red sweet orange. Debaje *et al* (2011) also found an increase in fruit weight with 2% KNO_3 + GA_3 100 ppm in acid lime. Jagtap *et al* (2013) also reported increased fruit weight with GA_3 50 ppm in kagzi lime. The increase in weight of fruit due to GA_3 100 ppm treatment was also recorded by Jain *et al* (2014) in Nagpur mandarin and Debbarma and Hazarika (2016) in acid lime. The higher fruit growth with GA_3 treated fruits might be due to mediating process for faster translocation and mobilization of photosynthates from source. Fruit weight also exhibited the same pattern as in fruit size, with treatment T_6 maintaining its superiority over other treatments. The increment in fruit weight might be due to hormone directed to transportation and accumulation of photosynthates which resulted in better fruit development and also acceleration of cell division, elongation, and enlargement and increase in inter cellar spaces in the mesocarpic cells.

Juice (%):-

Highest juice per cent (50.06) was recorded in the treatment spraying GA_3 25 ppm which was followed by spraying GA_3 20 ppm and borax 0.5 per cent with (49.50) and (49.06) per cent respectively, whereas the lowest juice (41.20) percentage was recorded in control. The results are in conformity with the findings of Mukunda*et al* (2014). Similar

results are also recorded by Saleem *et al* (2008) in sweet orange. Nawaz *et al* (2008) in kinnow mandarin and Jagtap *et al* (2013) in kagzi lime. As opined by Dabbarma and Hazarika (2016) juice is an important parameter possessing high value in processing and is related to various attributes such as fruit size, genetic characteristics of each cultivar and cultural practices.

Number of fruits per tree:-

The number of fruits per tree varied significantly between the treatments. Among the various treatments evaluated number of fruits per tree was found to be significantly highest (302) with the treatment GA_3 25 ppm. However the lowest number of fruits (233) per tree was recorded with the water spray (control). Higher number of fruits per trees was recorded in GA_3 followed by NAA. It might be due to more availability of GA_3 and NAA out of which NAA is a synthetic auxin. The abscission or dropping of fruit might be due to the low auxin activity or limited supply of auxins. The increase in the number of fruits per tree could be attributed to increased flower set as observed with the treatments initially resulting in the more number of fruits per tree. The results are in conformity with the findings of Tripathi and Dhakal (2005) and Devi *et al* (2011) in acid lime. Jagtap *et al* (2013) who reported significant increase in the number of fruits per tree with the application of NAA 200 ppm in kagzi lime also supports the present findings. Nawaz *et al* (2008) also reported the same.

Fruit yield (kg):-

The perusal of data regarding fruit yield of baramasi lemon as affected by foliar application of NAA, GA_3, borax and KNO_3 indicated that different concentrations tried exerted a significant influence on fruit yield. Significantly higher fruit yield (17.93 kg) was obtained from the plants treated with GA_3 25 while minimum (12.15 kg) was under control. Yield is the culmination of the inter play of several factors like bio-chemical, physiological and yield parameters. The increase in yield might be due to more fruit set, fruit retention and number of fruits per tree and more availability of gibberellic acid. Gibberellic acid promotes cell elongation, cell enlargement, increases in number of cells and also helps in increasing fruit volume, diameter and weight ultimately the fruit yield per tree. Similar results were obtained by Mukunda *et al* (2014) in acid lime. The increased fruit yield might be attributed to the synthesis of chlorophyll from the source to sink which might have led to an increased carbohydrate metabolism which might be due to more vegetative growth attained with GA_3, which increased the vegetative shoot development at the initial sprays. KNO_3 sprays at later stages might have helped to set more fruits leading to the highest yield per tree. The results are in agreement with the findings of Thirugnanavel *et al* (2007) in acid lime and Jain *et al* (2014) in Nagpur mandarin. Debbarma and Hazarika (2016) also reported the same in acid lime.

Total soluble solids (°Brix):-

It is evident from the data that all the treatments significantly affected the TSS. Maximum TSS (7.85°Brix) was recorded with GA_3 25 ppm. All the treatments were statistically at par with each other. TSS content of the fruits was the least (7.25°Brix) under control T_{13}. These findings are in close conformity with the research of Debaje*et al* (2011) and Debbarma and Hazarika (2016) in acid lime. The higher TSS content in the treatments involving plant growth regulators viz., GA_3 and NAA might be due to the stimulation of the functioning of enzymes involved in physiological processes and due to an increase in the mobilization of carbohydrates from source to sink as opined by Mukunda*et al* (2014).

Titratable acidity (%):-

Acidity of fruits was increased by the application of all the chemicals, however maximum reduction was noted with control. The treatment of GA_3 25 ppm recorded the maximum acidity of 5.80 per cent and 4.85 per cent was recorded least under control. NAA also showed an increase in acidity with the increased concentration. The fruits under borax and KNO_3 also registered the maximum acidity with increase in concentration of foliar sprays as compared to control. Increase in acidity could be attributed to an increased osmotic pressure by cell expansion due to auxins, which lead to accumulation of organic acids. Work of Josan*et al* (1995) and Mostafa*et al* (2005) also lends support to the present findings. The results are contradictory with the results of Debaje*et al* (2011), Jagtap*et al* (2013) in acid lime, Nawaz *et al* (2008) in kinnow mandarin. The reasons for the increased in acidity levels in the treated plants are not clearly known and needs further investigation.

TSS: acid ratio:-

TSS: acid ratio is the ratio of the percentage of total soluble solids (TSS) and titratable acidity. The minimum TSS: acid ratio (1.30) was calculated in the plants treated with GA_3 15 ppm. The maximum TSS: acid ratio (1.49) was

found under control. Results of these findings are also confirmed by Baskaran and Sathiamurthy (2008) in papaya, Kaur *et al* (2013) and Godara *et al* (2002) in grapes.

Ascorbic acid (mg/100ml juice):-

The data related to ascorbic acid content as influenced by NAA, GA_3, borax and KNO_3 depicted that it was significantly influenced by the application of growth regulators. Significant ascorbic acid content (54.21 mg/100ml juice) was recorded in fruits obtained from the trees treated with treatment (GA_3 25 ppm). The increase in ascorbic acid content might be due to the catalytic influence of the growth substances on the biosynthesis of ascorbic acid from sugars. Inhibited activity of oxidative enzyme and enhanced photo-phosphorylation prolonged the photo synthesizing ability of chlorophylous leaves and fruits. However minimum ascorbic acid content (45.53 mg/100ml juice) was recorded under the control. These results were in line with the findings of Sindhu and Singhrot (1993) who reported maximum ascorbic acid content in GA_3 treated fruits. Singh *et al* (2007) also observed higher ascorbic acid content in aonla fruits treated with micronutrients and plant growth regulators (10 ppm NAA and 25 ppm GA_3). Similar findings were also observed by Debbarma and Hazarika (2016) in acid lime, Nawaz *et al* (2011) with kinnow mandarin. Debaje *et al* (2011) also reported the same in acid lime. Jagtap *et al* (2013) also found maximum ascorbic acid content with GA_3 50 ppm in kagzi lime.

Table 1:-Influence of foliar sprays of NAA, GA_3, borax and KNO_3 on fruit physical parameters and yield in baramasi lemon.

Treatments	Fruit size (cm)					
	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Juice (%)	Number of fruits per tree	Fruit yield (kg) per tree
T_1 - NAA 25 ppm	5.30	4.85	59.16	47.59	273	16.97
T_2 - NAA 50 ppm	5.60	5.20	62.70	47.83	288	17.15
T_3 - NAA 75 ppm	5.85	5.40	65.34	48.10	293	17.69
T_4 - GA_3 15 ppm	5.50	5.25	62.98	48.79	286	17.12
T_5 - GA_3 20 ppm	5.75	5.50	66.62	49.50	296	17.71
T_6 - GA_3 25 ppm	5.95	5.60	68.86	50.09	302	17.93
T_7 - Borax 0.5%	4.90	4.85	56.60	49.06	286	16.62
T_8 - Borax 1%	4.95	5.11	58.02	48.87	278	16.57
T_9 - Borax 1.5%	5.0	4.95	58.93	48.27	271	16.23
T_{10} - KNO_3 1%	4.95	4.80	53.97	45.07	266	14.55
T_{11} - KNO_3 1.5%	5.05	4.90	55.12	46.97	274	15.86
T_{12} – KNO_3 2%	5.20	4.95	56.31	47.39	281	16.12
T_{13} – Control	4.75	4.40	52.73	41.20	233	12.15
Mean	0.28	0.27	0.88	0.52	9.03	0.33
CD at 5% level	0.09	0.09	0.30	0.17	3.07	0.11

Table 2:-Influence of foliar sprays of NAA, GA_3, borax and KNO_3 on fruit bio-chemical parameters in baramasi lemon.

Treatments	Total soluble solids (°Brix)	Titratable acidity (%)	TSS : acid ratio	Ascorbic acid (mg/100ml juice)	Juice (%)
T_1 - NAA 25 ppm	7.47	5.58	1.33	49.87	47.59
T_2 - NAA 50 ppm	7.63	5.65	1.35	51.31	47.83
T_3 - NAA 75 ppm	7.72	5.71	1.35	53.08	48.10
T_4 - GA_3 15 ppm	7.45	5.66	1.31	51.17	48.79
T_5 - GA_3 20 ppm	7.65	5.72	1.33	52.73	49.50
T_6 - GA_3 25 ppm	7.85	5.80	1.35	54.21	50.09
T_7 - Borax 0.5%	7.80	5.23	1.48	47.88	49.06
T_8 - Borax 1%	7.75	5.29	1.46	48.27	48.87
T_9 - Borax 1.5%	7.65	5.36	1.42	49.34	48.27
T_{10} - KNO_3 1%	7.38	5.35	1.38	48.91	45.07
T_{11} - KNO_3 1.5%	7.47	5.43	1.37	49.62	46.97

T_{12} – KNO_3 2%	7.58	5.56	1.36	50.02	47.39
T_{13} – Control	7.25	4.85	1.49	45.53	41.20
Mean	0.12	0.13	0.04	0.45	0.52
CD at 5% level	0.04	0.04	0.014	0.15	0.17

Conclusion:-

It is concluded from the present study that the foliar spray of GA_3 25 ppm proved to be the most effective treatment for maximizing the fruit yield and improving the quality for baramasi lemon growers.

References:-

1. Ahmed W, Ziaf K, Nawaz M A, Saleem B A, Ayyub C M (2007) Studies on combining ability of citrus hybrids with indigenous commercial cultivars. *Pak J Bot **39**: 47-55.*
2. Asad A, Blamey F P C, Edwards D G (2003) Effects of boron foliar applications on vegetative and reproductive growth of sunflower. *Ann Bot **92**: 565-70.*
3. Baskaran A and Sathiamurthy S (2008) Effect of growth retardants on quality of papaya (*Carica papaya* Linn) cv. CO 2. *The Asian J hort**3:** 313-314.*
4. Berhow M A (2000) Effect of early plant growth regulator treatments on flavanoid levels in grapefruit (*Citrus paradisi*). *Plant Growth Regulation **30**: 225-32.*
5. Bhatia B S and Yadav R K (2005) Effect of foliar spray of urea and NAA on fruit yield and quality of ber (*Z. mauritiana*Lamk.). *National Seminar on Commercialization of Hort in Non-traditional Areas C.I.A.H Bikaner (India) 119.*
6. Bhatt B B, Rawat S S, Naithani D C, Kumar D and Singh KK (2016) Effect of foliar application of bio-regulators and nutrients on growth and yield characters of lemon. *Dept of Hort HNB GarhwalUni Srinagar **16**: 821-25.*
7. Debage P P, ShindeEkta D, Ingale H V (2011) Effect of plant growth regulators and nutrients on quality of acid lime (*Citrus aurantifolia*). *Asian J Hort**6**: 253-55.*
8. Debbarma N and Hazarika B N (2016) Effect of plant growth regulators and chemicals on yield and quality of acid lime (*Citrus aurantifolia*Swingle) under foot hill condition of Arunachal Pradesh. *Int J AgriEnv and Biotech **9**: 231-36.*
9. Devi H L, Sarkar S K, Dhanabati L and Majhi D (2011) Flushing–flowering behavior and regulation in acid lime – a critical review and research interventions. *J Crop and Weed **7**: 87–90.*
10. Dixit A, Shaw S S and Pal V (2013) Effect of micronutrients and plant growth regulators on fruiting of litchi. *Hort Flora Res Spectrum **2**: 77-80.*
11. El-Agamy S Z, El-Sese A M and Mohamed A K A (2004) Seed formation, leaf dimensions and fruit characteristics of Balady limes (*Citrus aurantifolia*) in relation to some GA_3 treatments. *IntSocCitri 208-11.*
12. Gaur B, Beer K, Hada T S, Kanth N and Syamal M M (2014) Studies on the effect of foliar application of nutrients and GA_3 on fruit yield and quality of winter season guava. *Ecoscan Special Iss**6**: 479-83.*
13. Godara A K, Chauhan K S and Kumar A (2002) Effect of various pre harvest treatments on the quality of Thompson seedless grapes. *Haryana J HortSci**31:** 164-67.*
14. Jagtap V M, Patel H C, Nehete D S and Godage S S (2013) Effect of foliar application of plant growth regulators and micronutrients on yield and quality of acid lime cv. kagzi (*Citrus aurantifolia*Swingle). *The Asian J Hort**6**: 253–55.*
15. Jain M C, Choudhary H D, Sharma, M K and Singh B (2014) Yield and quality attributes of nagpur mandarin as affected by use of different plant growth regulators.*Env. & Eco. **32**: 1141-45.*
16. Josan J S, Sandhu A S, Singh R and Dhillon D S (1995) Effect of plant growth regulators and nutrients on fruit cracking in lemon. *Indian J Hort**52**: 121-24.*
17. Kachave D B and Bhosale A M (2007) Effect of plant growth regulators and micronutrients on fruiting and yield parameters of kagzi lime (*Citrus aurantifolia*Swingle) fruits. *The Asian J Hort**2**: 75-79.*
18. Kaur M, Gill M I S and Arora N K (2013) Effect of pre-harvest treatment on yield, maturity and quality of Flame seedless grape (*Vitisvinifera* L). *J HortSci**8:*** 35-40.
19. Khehra S and Bal J S (2014) Influence of foliar sprays on fruit cracking in lemon. *Int J of Plant, Animal and EnvSci**4**: 124-28.*
20. Liu YQ, Heying E and Tanumihardjo S A (2012) History, global distribution and nutritional importance of citrus fruits. *Comprehensive Reviews in Food Sci and Food Safety **11**: 530-45*

21. Mostafa E A M, Hassan H S A and El-Sabag A S (2005) Influence of spraying $GA_3$and KNO_3 on yield, fruit quality and leaf mineral contents of Balady mandarin trees. *Minufiya J Agri Res **30**: 283-95.*
22. Mukunda L L, VenkataRamana K T, Sivarama Krishna V N P, Yuvaraj K M, Naga Lakshmi T, Sarada G, GouriSankar T, Gopi V and Gopal K (2014) Effect of growth regulators and chemicals on fruit yield and quality of hasta bahar flowering in acid lime (*Citrus aurantifolia*Swingle) cv. Balaji. *J Agri and Allied SciIss 3.*
23. Nawaz M.A, Ahmad W, Ahmad S, Khan M M (2008) Role of growth regulators on pre-harvest fruit drop, yield and quantity in kinnowmandarian. *Pakistan J Botany **40**: 1997-81.*
24. Nawaz M A, Ahmad W, Ahmad S and Khan M M, Jaime A T, Naeem A, Shahzad M, HameedUllah and Hussain Z (2011) Exogenous application of 2,4-D, GA_3 and NAA at flowering improves yield and quality of Kinnow mandarin (*Citrus reticulata* Blanco). *The Asian and Australasian J Plant Sci and Biotech **5**: 17-21.*
25. Saleem B A Malik A U, Pervez M A and Khan A S (2008) Spring application of growth regulators affects fruit quality of Blood Red sweet orange. *Pak J Bot **40**: 1013-23.*
26. Shinde B B, Ingle H V, Dhawale D U, Hajare A R and Dhobe S G (2008) Effect of plant growth regulators on size, yield and quality of acid lime. *J Soils & Crops **18**: 117-20*
27. Sindhu S S and R S Singhrot (1993) Effect of pre-harvest spray of growth regulators and fungicides on the shelf life of lemon cv. Baramasi. *Haryana J HortSci : 204-06.*
28. Singh J K, Parsad J and Singh H K (2007) Effect of micronutrients and plant growth regulators on yield and physico-chemical characteristics of aonla fruits in cv. Narendra Aonla-10. *Ind J Hort**64**: 216-18.*
29. Thirugnanavel, A Amutha, R Beby Rani, W Indira, K Mareeswari, P Muthulaksmi, S and Parthiban S (2007) Studies on regulation of flowering in Acid lime (*Citrus aurantifolia*Swingle). *Res J of and Bio Sci**3**: 239–41.*
30. Tripathi K M and Dhakal D D (2005) Effect of paclobutrazol on off-season flower induction in acid lime (*Citrus aurantifolia*Swingle) landraces under chitwan condition. *J InstAgri Animal Sci**26**: 87-92.*
31. Yadav D N and Chaturvedi O P (2004) Influence of GA_3 and trace elements on fruit drop, growth and quality of Ber (*Zizyphusmauritiana*Lamk.) cv. Banarsi Karaka. *Farm Sci J **14**: 27-28.*