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Production Potential of Guava as Influenced by Nitrogen and Boron Levels as Well as Macro and Micro Nutrient Content in Leaf

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A B S T R A C T

The flowering characteristics, fruit set and fruit drop had a positive effect with the various doses of nitrogen and boron. The boron applied @ 50g/plant took minimum days for flowering (81.64 days), maximum fruit set (74.67 %), minimum fruit drop (35.05 %) and days for harvesting (98.86 days). The flowering to harvesting is decreased by 17 days with application of boron @ 50g/plant. The maximum fruit yield and fruit yield efficiency was recorded 54.37 kg/plant and 6.04 kg/plant respectively when CAN apply @ 600 g/plant. The maximum fruit weight was also obtained (330.12 g) when CAN applied @ 600 g/plant. Whereas, boron applied @ 50 g/plant produced fruit weight of 307.30 g. The highest nitrogen (1.75%) and phosphorous (0.21%) was recorded with CAN applied @ 600 g/tree. In effect of boron, maximum nitrogen (1.71%) and phosphorous (0.20%) content in leaves was obtained with application of boron @ 50 g/tree followed by boron applied @ 75 g/tree.

Introduction

Guava (*Psidium guajava* Linn.) belongs to the family Myrtaceae and native to tropical America. It is being grown commercially in the tropical as well as subtropical parts of all over the world. It was introduced by Spanish and Portuguese in India since early 17th century and gradually become a crop of commercial significance. As an important fruit crop of India, it has gained considerable prominence on account of its high nutritive value, availability at moderate price, a pleasant aroma and good flavour, so it is called as 'the apple of tropics'. Now it is so much acclimatized that it appears to be native of India (Samson 1980). It is a small tree with prolific bearing habit, bears more than once a year. Its trees are quite hardy and give satisfactory return without much care and hence the ability to withstand wide range of soils and climatic conditions. Nutrients are essential for the productivity and quality of different fruits. Hence, the determination of nutritional needs for efficient production of high quality fruits is an important aspect of nutrient management for the orchardists.

One of the important factors which limit the production is nutrients and season of crop. Nitrogen plays a dominant role because it is an essential constituent of protein, nucleic acid, nucleotide, amino acids, protoplasm, chlorophyll, Intro Phospholipids, alkaloid, enzymes, hormones, vitamins, etc. It is a part of purines, pyrimidine, prophyrines and co-enzymes. It is essential for carbohydrates utilization within plants. It imparts vigorous vegetative growth and dark green colour to plants, produces early growth and delays maturity of plants, and governs the utilization of potassium, phosphorus and other elements.

Boron is the key nutrient for flowering, fruiting and as well as the internal and external fruit quality. It is involved in sugar transport, lignification, RNA metabolism, respiration, indole acetic acid (IAA) metabolism, cell wall synthesis, carbohydrate metabolism etc. (Jeremy, 2007). In fruit crops, Boron deficient trees exhibit little shoot growth, some buds may fail to open, whereas others may open and then shrivel and die. Shoots may grow for some time and then tips cease growth and die. Leaves are distorted in shape, with regular serration; leaves may cup or roll in a downward direction and feel thick and leathery. Fruits may become hard shrivelled and blotchy.

Like boron, calcium is also an important nutrient in plant nutrition. There has been increasing interest in the use of calcium due to the beneficial effects on fruit quality and shelf-life. Calcium is considered as one of the most important nutrient elements in controlling the metabolism of plant cells. Its role in preventing various physiological disorders is well known. Calcium regulates the absorption of nutrients across the cell membranes and plays important role in plant cell elongation and division, structure and permeability of the cell, nitrogen and carbohydrate metabolism. Calcium is necessary to maintain membrane stability and is an integral part of cell wall which it provides rigidity (Conway *et al.,* 2002). However, there is increasing evidence that there may be different optimal nutritional levels. Keeping in view the above facts, an experiment was conducted to study the effect of nitrogen and boron on yield as well as leaf macro and micro-nutrient content.

Materials and Methods

The experiments were carried out in horticultural garden of Bihar Agricultural College, Sabour Bhagalpur during the winter season of the year 2012 and 2013. The investigation was conducted on 9 years old plants of guava cv. 'Allahabad Safeda'. Nitrogen sources were used from urea and calcium nitrate and their level of nitrogen applied (a.i) @ 400, 600 and 800 g/plant. Phosphorous and potassium applied uniformly in all the treatments. Boron applied @ 0, 50 and 75 g/plant as basal doses. The $2/3^{rd}$ and $1/3^{rd}$ dose of nitrogen applied during last week of June and September respectively. The experiment was laid out in Randomized Block Design (Factorial) replicated thrice. The appearances of minimum twenty fresh flowers per tree per day were kept as criteria for the beginning of flowering. Total number of fruits set on the selected branches was counted a fort night after completion of flowering. The percentage of fruit set was calculated from the total number of flowers previously recorded. The number of fruits reaching harvest maturity was counted and percentage of fruit drop was calculated from the total number of fruit set noticed earlier. The date of maturity of fruits in each replication of all treatments was noted and the average time taken for maturity in days was calculated in case of all treatment. The yield of fruits per plant was recorded by weighing the harvested fruits in different pickings. The average yield per plant in kilogram was noted. The yield of fruits per square meter was recorded by weighing the harvested fruits in different pickings. The average yield per square meter in kilogram was noted.

Leaf samples were collected in the month of July after 25 days fertilizer application. Fifty leaflets with petiole were collected- randomly from all compass sides of the trees. 3rd pair of currently matured leaves along with petiole, from each tree replicated thrice was collected. To avoid any possible variation, 50 complete undamaged and disease free leaves were collected.

Leaves were collected in perforated paper bags and brought to the laboratory on the same day in ice-boxes to prevent enzymatic degradation. The leaf sample were thoroughly washed first with tap water, then dipped in 0.1 N HCl, distilled water and finally in double distilled water. After air drying the samples was dried in hot air oven at 65^oC till constant weight was obtained. The dried leaves were grinded in steel Wiley mill and then kept in butter paper bags for chemical analysis. The procedure adopted for different macro and micronutrient analysis are given below:

Analysis of leaf N content

Digestion

One gram of processed sample was taken in the digestion tube along with digestion mixture containing 10:1 K_2SO_4 and $CuSO_4$. Then 10 ml of concentrated H_2SO_4 was added and the tube was kept overnight. Then the tube was kept in the digestion block for saturation obtained for one hour at 390^oC till a clear digest.

Distillation

Ten to fifteen ml distilled water was added to the cooled micro Kjeldhal tube containing digested material. After cooling, 40% Na OH was added and the distillation was carried out. The liberated ammonia was collected in a 250 ml conical flask containing 20 ml of H_3BO_3 and mixed indicator. The distillation was continued for 10-20 minutes and the distillate was continued for 1-20 minutes and the distillate was titrated against 0.1 N H_2SO_4. Simultaneously, a blank titration was also conducted. Finally, the N content in the leaves was expressed in percentage.

Digestion of plant material for P, K, Ca and micronutrient

0.5 g powdered sample of leaf of guava was taken in 100 ml flask and was digested in di-acid mixture of nitric acid and perchloric acid in 9:4 ratios. The flask were placed on a hot plate at 115-118^oC for digestion. The digested sample was filtered and was diluted with double distilled water to make a volume of 50 ml which was ultimately used for estimation of macro and micronutrients.

The phosphorus content was determined by using ammonium molybdate ammonium metavanedate. The colour intensity was measured at 440 nm in a spectrophotometer. Leaf potassium and calcium were determined with flame photometry technique using corning flame photometer, U.K. (Jackson, 1967). The elements were analyzed buying the diacid digested material using Atomic Absorption Spectrophotometer for the estimation of Zn, Fe and Mn.

Results and Discussion

During the course of investigation, it was observed that fruit set percentage enhanced (Table 1) due to enrichment of nutrient status of soil. Calcium Ammonium Nitrate and urea used @ 600 g/plant did not exhibit significant difference in fruit set percentage. Whereas, response of borax @ 50 g/plant produced fruit set (74.64 %) as soil application, which was found better than Calcium Ammonium Nitrate and urea @ 600 g/plant. The increased fruit set due to borax treatments might be due to involvement of boron in reproduction, germination of pollen tube and fertilization processes. According to Romenskaya (1973) treatments of plants with boron improves fruit formation by stimulating pollen germination and growth of pollen tube.

The results from present experiment revealed, remarkable influence of borax, on drop of fruits Table 1. However, plant with application of boron @ 75 g/plant exhibited minimum fruit drop. Calcium Ammonium Nitrate and urea @ 800 g/plant was observed to be the best (36.10 % and 37.94%) to check fruit drop in guava cv. Allahabad safeda. The lowest fruit drop due to borax treatments might be due to involvement of boron on carbohydrate which might be helpful in checking fruit drop. It also assists in auxin balance to prevent fruit drop. The increase in content of auxin may be attributed to different factors like increased synthesis of tryptophan which is precursor of auxin presumably resulting from an increased activity or synthesis of tryptophan synthatase or to the inactivation of peroxidase activity, leading to more accumulation of auxin. Thus in present case, borax, urea and calcium ammonium nitrate appear to have protected the endogenous auxin from oxidation and helped in checking fruit drop. The results of present experiment find support from the work of chaitanya *et al.,* (1997 a) who obtained increased fruit retention in guava as a results of borax spray. Similar views were supported by other workers in fruit crops viz., Brahmachari and Kumar (1997) in litchi, Response of urea and calcium ammonium nitrate towards decrease in fruit drop is in agreement with finding of Ahmad *et al.,* (1998) in guava.

It would be evident from Table 1 application of nitrogen at different doses and its sources with borax exhibited remarkable effect on fruit maturity. Application of borax @50 g/plant advanced the maturity of fruit by 17-18 days, whereas, application of Calcium Ammonium Nitrate @ 800 g/plant advanced the maturity of fruits by 10-11 days. The earliness in fruit maturity due to borax application may probably be due to the translocation of sugars and synthesis of cell wall materials and increases in methy estarase activity as reported by Shek (1958) in apple. Early ripening following borax application is an agreement with the finding of Pathak and Pandey (1988) and kundu and Mitra (1999) in guava. The results of present finding are in supports with Goswami *et al.,* 2012 and Sharma *et al.,* 2013)

The fruit yield per plant and fruit yield efficiency kilo gram per meter square are observed highest (54.37 kg/tree and 6.04 kg/m^2) with Calcium Ammonium Nitrate @ 600 g/plant followed by application of urea @ 600 g/tree (51.42 kg/tree and 5.69 kg/tree) from Table 2. The yield per plant is directly dependent upon the percentage of fruit set and fruit drop. The Calcium Ammonium Nitrate can increase the fruit set and decrease the fruit drop will naturally yield more fruit pre plant. In present investigation, borax applied @ 50 g or 75 g/tree have favoured increased fruit set and decrease fruit drop and thus caused more fruits yield (50.09 kg/tree) per plant to reach the stage of harvest. Chaitanya *et al.,* (1997 a) found significant increase in fruit yield of borax sprayed guava trees. Lal and Sen (2002) noted significant increase in number of guava fruits by foliar spray of calcium ammonium nitrate. The increase in number and size of fruits due to application of Calcium Ammonium Nitrate might be attributed to improvement in vegetative and reproductive growth of the plant, which activates the process of cell division and cell elongation of fruits. Vegetative growth enhanced dry matter production. This might have been acted as an activator for number of complex enzyme systems and these enzymes catalyse metablic reactions related to the carbohydrates, nucleic acid and nucleotides, amino acid, protein and folic acid. Yield enhanced by borax application are in agreement with the finding of Athani *et al.,* (2009) and Dinesh kumar *et al.,* 2009.

Significantly heavier weight of fruit was achieved by both application of calcium ammonium nitrate and borax Figure 1. The application of Calcium Ammonium Nitrate @ 600 g/plant (330.22 g) and borax @ 50 g/plant (307.30 g) produced the best effect. The split application of Calcium Ammonium Nitrate as a source of nitrogen makes available nutrient through the growth and development of fruits leads to heavier weight of fruits. The increase in fruit weight due to application of Calcium Ammonium Nitrate may probably due to more uptake of oxygen and translocation of sugar. Another reason for heavier fruit weight under calcium ammonium nitrate may be high level of auxin in the various parts of the fruits obtained by calcium. Because of higher production of chlorophyll by nitrate, there might have been higher photosynthetic efficiency and production of photosynthates which found their way into fruits. Influence of calcium and nitrogen on fruit weight is supported by findings of Kunda and Mitra (1999) and Bhatia *et al.*, (2001) in guava

The leaf nutrient content under the influence of nitrogen and boron significantly varied with the different treatments (Table 3). The nitrogen content in leaves of guava ranged from 1.57% to 1.75%.The maximum nitrogen content (1.75%) in leaves was obtained with urea and CAN applied @ 600 g/plant followed by CAN applied @ 800 g/plant and urea applied @ 600 g/plant (1.65%). Application of boron improved the absorption of majorThe leaf nutrient content under the influence of nitrogen and boron significantly varied with the different treatments (Table 3). The nitrogen content in leaves of guava ranged from 1.57% to 1.75%. The maximum nitrogen content (1.75%) in leaves was obtained with urea and CAN applied @ 600 g/plant followed by CAN applied @ 800 g/plant and urea applied @ 600 g/plant (1.65%). Application of boron improved the absorption of major nutrient in plant. Under various doses of boron application, boron applied @ 50 g/plant obtained maximum nitrogen content (1.71%) in guava leaves.

The highest phosphorous content in leaves (0.21%) was recorded with CAN applied @ 600 g/plant and urea applied @ 800g/ plant (Table 3), while it was lowest (0.18 %) in CAN applied @ 400 g/plant. It is evident from table that the sources of nitrogen had positive effect on the leaf phosphorous content. The doses of boron application did not show any significant difference in absorption of phosphorous content in leaves. Boron applied @ 50 g and 75 g/plant recorded 0.20% leaves phosphorous content as compared to 0.18 % in control. However, the maximum potassium content (1.59%) in leaves was found with CAN applied @ 600 g/plant and recorded the lowest potassium content (1.35 %) with urea applied @ 400 g/plant. Application of boron also improved the absorption of potassium content in plant. The leaves potassium content increased from 1.35% (Without boron) to 1.55% (B @ 50 g/plant).

The calcium content in leaves varied significantly under the influence of different sources of nitrogen and boron (Table 3). The maximum calcium content (0.79%) in leaves was recorded with CAN applied @ 800 g/plant, which was at par with CAN applied @ 600 g/plant (0.77%). The lowest calcium content (0.68%) in leaves was observed with urea applied @ 400 g/plant. The doses of boron did not show any significant effect in the calcium content of guava leaves. However, the maximum calcium content (0.76%) in leaves was recorded with boron applied @ 50 g and 75 g /plant.

Table.1 Effect of nitrogen and boron on yield contributing characters of guava cv. Allahabad safeda

Treatments	Days of flowering (initial)	Fruit set (%)	Fruit drop (%)	Days of harvest/maturity
Effect of nitrogen				
Urea @ 400g/plant	89.61	66.02 (54.44)	43.98 (41.52)	109.50
Urea @ 600g/plant	83.95	69.59 (56.66)	40.41 (39.43)	101.95
Urea @ 800g/plant	84.44	68.77 (56.14)	37.94 (37.98)	106.55
CAN @ 400g/plant	87.78	67.01 (55.06)	42.98 (40.93)	108.33
CAN @ 600g/plant	83.28	71.73 (57.79)	39.69 (39.00)	104.34
CAN @ 800g/plant	82.45	70.78 (57.51)	36.10 (36.83)	98.67
SE ± m	1.41	0.73	0.38	1.40
C D at 5%	3.98	2.06	1.08	3.94
Effect of boron				
Boron @ 0g/plant	92.14	61.28 (51.55)	43.91 (44.60)	115.86
Boron @ 50g/plant	81.64	74.64 (59.88)	36.20 (36.96)	98.86
Boron @ 75g/plant	81.97	70.83 (57.38)	35.05 (36.28)	99.95
SE ± m	1.01	0.53	0.27	1.01
C D at 5%	2.87	1.50	0.77	2.85

Table.2 Effect of nitrogen and boron on yield contributing characters of guava cv. Allahabad safeda

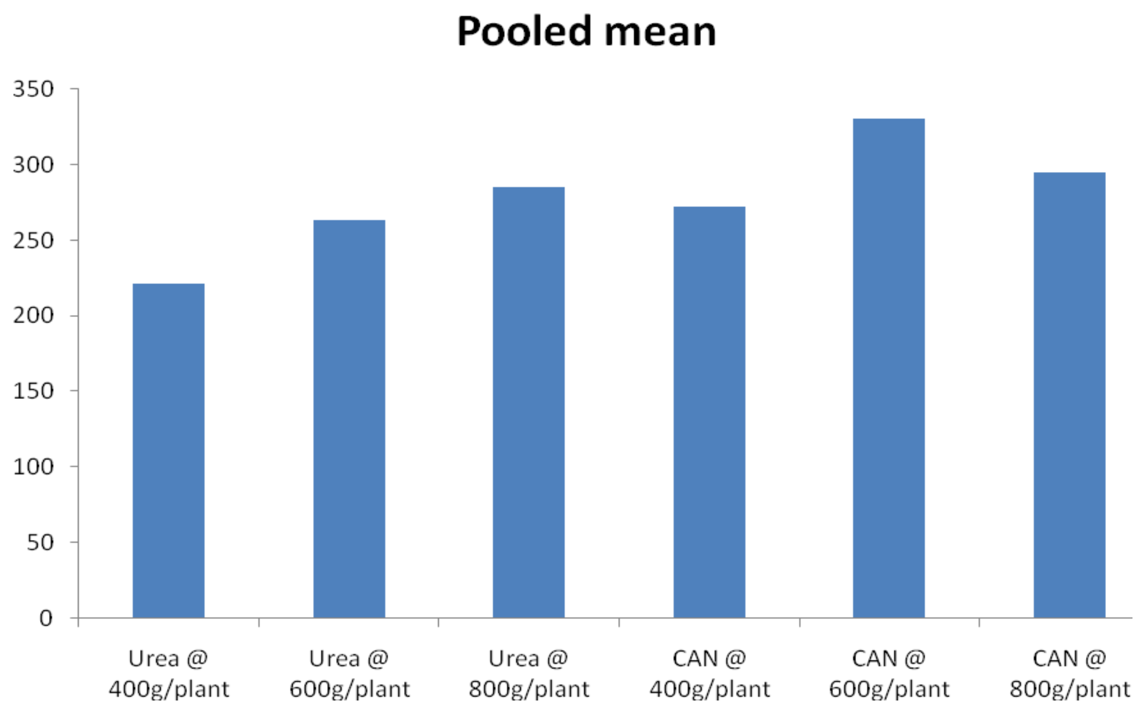
Treatments	Yield (Kg/plant)	Fruit yield efficiency (kg/m^2)
Effect of nitrogen		
Urea @ 400g/plant	43.05	4.77
Urea @ 600g/plant	51.42	5.69
Urea @ 800g/plant	46.19	5.13
CAN @ 400g/plant	43.23	4.89
CAN @ 600g/plant	54.37	6.04
CAN @ 800g/plant	49.37	5.48
SE ± m	0.69	0.07
C D at 5%	1.95	0.21
Effect of boron		
Boron @ 0g/plant	44.42	4.93
Boron @ 50g/plant	50.09	5.61
Boron @ 75g/plant	49.31	5.46
SE ± m	0.50	0.05
C D at 5%	1.41	0.15

Table.3 Effect of nitrogen and boron on macro nutrient content (%) in guava leave cv. Allahabad Safeda

Treatments	Nitrogen (%)	Phosphorous (%)	Potassium (%)	Calcium (%)
Effect of nitrogen				
Urea @ 400g/plant	1.57	0.19	1.35	0.68
Urea @ 600g/plant	1.75	0.19	1.55	0.73
Urea @ 800g/plant	1.65	0.21	1.45	0.76
CAN @ 400g/plant	1.54	0.18	1.40	0.70
CAN @ 600g/plant	1.75	0.21	1.59	0.77
CAN @ 800g/plant	1.65	0.19	1.53	0.79
SE ± m	0.016	0.0022	0.013	0.008
C D at 5%	0.047	0.0064	0.037	0.022
Effect of boron				
Boron @ 0g/plant	1.55	0.18	1.35	0.70
Boron @ 50g/plant	1.71	0.20	1.55	0.76
Boron @ 75g/plant	1.69	0.20	1.53	0.76
SE ± m	0.012	0.0016	0.009	0.005
C D at 5%	0.34	0.0046	0.026	0.016

Table.4 Effect of nitrogen and boron on micro nutrient content (%) in guava leave cv. Allahabad Safeda

Treatments	Zinc (ppm)	Magnesium (ppm)	Iron (ppm)
Effect of nitrogen			
Urea @ 400g/plant	64.30	0.19	140.02
Urea @ 600g/plant	70.11	0.19	149.43
Urea @ 800g/plant	71.35	0.21	158.70
CAN @ 400g/plant	67.18	0.18	145.58
CAN @ 600g/plant	72.70	0.21	153.72
CAN @ 800g/plant	72.11	0.19	136.99
SE ± m	0.784	0.0022	1.85
C D at 5%	2.20	0.0064	5.20
Effect of boron			
Boron @ 0g/plant	65.54	0.18	143.63
Boron @ 50g/plant	71.80	0.20	152.12
Boron @ 75g/plant	71.54	0.20	146.48
SE ± m	0.567	0.0016	1.42
C D at 5%	1.59	0.0046	3.48



The zinc content in leaves of guava varied with different sources of nitrogen and boron application. A perusal of Table 4 clearly indicated that the zinc content in leaves was significantly highest (72.70 ppm) with CAN applied @ 600 g/plant, which was statistically at par with CAN @ 800 g/plant and urea @ 800 g/plant. The least zinc content (64.30 ppm) in leaves was found in urea applied @ 400 g/plant. No much significant variation was observed with doses of boron, although application of boron enhanced the zinc content in guava leaves. Boron applied @ 50 g/plant was recorded the maximum zinc content in leaves (71.80 ppm) and was at par with boron applied @ 75 g/plant (71.54 ppm).

The manganese content in leaves was significantly maximum (57.10 ppm) with CAN applied @ 400 g/plant followed by (54.28 ppm) with urea applied @ 400 g/plant. The lowest manganese content in leaves (42.17 ppm) was observed with urea applied @ 800 g/plant which was at par with CAN applied 800g/plant (42.57 ppm). Boron applied @ 75 g/plant reported the least manganese content (46.26 ppm). The highest manganese content (49.87 ppm) in leaves was recorded without boron application

The scrutiny of data revealed that the maximum iron content (158.70 ppm) in leaves was recorded with urea applied @ 800 g/plant, which was statistically at par with CAN applied @ 600 g/plant (153.72ppm). However, the lowest iron content (136.99 ppm) was observed when CAN was applied @ 800 g/Plant. Under different doses of boron no much significant variation was observed. Maximum iron content (152.12 ppm) in leaves was found with boron application @ 50 g/plant and the least (143.63 ppm) in plant without boron application.

Levels of leaf nutrients increased with enhancing doses of nitrogen from its sources like urea and calcium ammonium nitrate. The doses of urea applied @ 600 g/plant and calcium ammonium nitrate @ 600 g/plant showed almost maximum level of N, P, Ca, Fe and Zn. Beyond this doses, a decline in leaf nutrient composition was observed. The level of potassium in leaves decreased with increasing doses of calcium ammonium nitrate. Application of borax @ 50 g/plant was observed to improve the leaves nutrient like N, P, K, Ca, Mn, Cu, Zn and Fe. The decline in leaves nutrient status with application of borax @ 75 g/plant was recorded. The increased in leaf nutrient status may be due to enrichment of soil nutritional status and crop regulation of rainy season guava. Crop regulation acts like light pruning.

The above results are in conformity with the finding of Tarango and Ojeda (1999), Worley (1981), Singh *et al.,* (2010) and Grochowska *et al.,* (2005). Misra *et al.,* (2003) reported that optimum leaves nutrient contents had been obtained in the range of 1.63 to 1.96%(N), 0.18-0.24% (P) 1.31-1.71% (k), 0.76-0.83% (Ca) and 0.52 - 0.65% (Mg), 10ppm (B), 77.5ppm Zn and 75ppm Cu. The finding of Jaiprakash *et al.,* (2006) and Diwaker *et al.,* (2004) also support that the constituents of N, Zn and B had significant effects on the concentrations of N, P, K, Zn and B in leaves tissues. The highest yield (68.16 kg/plant) was obtained with 800 g N /plant. The treatment enhanced the levels of N and B, but reduced P, K and Zn levels in plants. Regarding calcium nitrate applied @ 0.5% and 1% leads to an increase in the level of N, P and Mg with an increase in calcium concentration. The leaf potassium content decreased with an increase in Ca concentration, which was more pronounced with foliar application.

Application of CAN @ 600 g/tree and boron @ 50 g/tree showed superiority in yield contributing characters like minimum days for flowering (81.64 days), maximum fruit set (74.67 %), minimum fruit drop (35.05 %) and days for harvesting (98.86 days) and maximum fruit yield and fruit yield efficiency was recorded 54.37 kg/plant and 6.04 kg/plant. It also improved the quality attributes like T.S.S, total sugar, ascorbic acid content and less physiological losses, which may be beneficial for the higher return. While maximum nitrogen (1.71%) and phosphorous (0.20%) content in leaves was obtained with above doses.

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