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EFFECT OF FOLIAR APPLICATION OF CALCIUM, ZINC AND BORON ON FRUIT RETENTION AND YIELD OF AONLA (*EMBLICA OFFICINALIS* GAERTN) CV. NA 7

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ABSTRACT

The present investigation entitled "Effect of foliar application of calcium, zinc and boron on fruit retention and yield of Aonla (*Emblica officinalis* Gaertn) cv. NA 7" was carried out during 2021-22 at Experimental Farm, Department of Fruit Science, Faculty of Horticulture, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in Randomized Block Design (RBD) with nine treatments and three replications. The different treatments viz., T_1 - (Calcium chloride 1 %), T_2 - (Calcium chloride 1.5 %), T_3 - (Zinc sulphate 0.4 %), T4 - (Zinc sulphate 0.6 %), T_5 - (Borax 0.4 %), T_6 - (Borax 0.6 %) T_7 - (Calcium chloride 1.0 % + Zinc sulphate 0.4 % + Borax 0.4 %), T_8 - (Calcium chloride 1.5 % + Zinc sulphate 0.6 % + Borax 0.6 %), T_9 - (Control), were used in research programme. Two sprays of each treatment were given at the pea stage and a thirty-day interval after the first spray. The results of the present investigation indicated that, treatment T_8 (Calcium chloride 1.5 % + Zinc sulphate 0.6 % + Borax 0.6 %) was found to be the best among all as it gives the reduced fruit drop (31.24 %) with increased fruit retention (68.76 %). It also gave maximum fruit weight (34.96 gm), yield per tree (64.60 kg) and yield per hectare (17.90 t) compared with control.

***Keywords* :** Calcium, Zinc, Boron, fruit drop, fruit retention, yield.

Introduction

Aonla (*Emblica officinalis* Gaertn syn. *Phyllanthus emblica* L.) is a commercially important fruit crop. It is a prolific bearer, quite hardy and remunerative even without much care. It belongs to the family Euphorbiaceae. Aonla is an important fruit of the future due to its high medicinal and nutritional value. Aonla is the richest source of vitamin "C" among all fruits after Barbados cherry. The aonla fruit contains about three times more protein and 160 times more vitamin "C" as compared to the apple (Meena *et al.,* 2014). Its fruit is valued as an anti-ascorbic, diuretic, laxative, antibiotic and cooling refrigerant. Calcium is well known to play an important function in maintaining the quality of fruits and vegetables. Calcium treatment aids in increasing vitamin C content, preserving fruit firmness, reducing storage breakdown and rotting, and also reducing fruit browning. Boron is required for ovule development, pollen tube growth, and fruit set. Boron is a component of cell membranes and is necessary for cell division. It regulates the plant's potassium-calcium ratio and helps with nitrogen absorption and sugar translocation. Boron increases the availability of nitrogen in plants. Zinc is a crucial trace element for plants, as it participates in numerous enzymatic activities and is required for proper growth and development. Zinc also helps regulate protein and carbohydrate metabolism. Foliar application is based on the idea that nutrients are rapidly absorbed by leaves and delivered to various parts of the plant to meet the functional requirements of nutrition. Obviously, it is an excellent method of avoiding nutrient availability issues. This method is extremely beneficial for the correction of element deficiencies, restoring disrupted nutrient supply, overcoming stress factors limiting their availability, and it plays a critical role in fruit productivity and quality, as well as the recovery of nutritional and physiological disorders in fruit trees. Various experiments have been conducted earlier on foliar spray of micro-nutrients in different fruit crops and have shown significant responses to improve the yield and quality of fruits (Shukla, 2011). Keeping in view the above aspects, the present experiment was initiated to study the effect of foliar application of calcium, zinc and boron on aonla.

Materials and Methods

The experiment was conducted on twenty-four years old healthy plants of aonla cv. NA-7 at Experimental Farm, Department of Fruit Science, Faculty of Horticulture, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in Randomized Block Design (RBD) with nine treatments and three replications. The different treatments viz., T_1 - (Calcium chloride 1 %), T_2 - (Calcium chloride 1.5 %), T_3 - (Zinc sulphate 0.4 %), T_4 - (Zinc sulphate 0.6 %), T_5 - (Borax 0.4 %), T_6 - (Borax 0.6 %) T_7 - (Calcium chloride 1.0 % + Zinc sulphate 0.4 % + Borax 0.4 %), T_8 - (Calcium chloride 1.5 % + Zinc sulphate 0.6 % + Borax 0.6 %), T_9 - (Control), were used in research programme. Two sprays of each treatment were given at the pea stage and a thirty-day interval after the first spray. The standard cultural operations, plant protection measures and basal application of manures and fertilizers were done as per the recommended schedule for aonla plantation in all treatments. The observations were recorded on fruit drop, fruit retention and yield.

Result and Discussion

1. Fruit drop (%)

The fruit drop was significantly influenced by the foliar application of calcium, zinc and boron. It is clear from the data (Table 1) that foliar application of nutrients significantly reduced fruit drop (Fig.1). However, numerically maximum fruit drop (45.20 %) was recorded with treatment T_9 (control) and minimum fruit drop (31.24 %) was noticed with treatment T_8 (Calcium chloride 1.5 % + Zinc sulphate 0.6 % + Borax 0.6 %). The reduction in fruit drop and increase in fruit retention in aonla fruits might be due to the reason that, boron and calcium being the main constituent of the cell wall (middle lamella) of plant cell in the form of calcium pectate play an important role in the strengthening of pedicel attached to the proximal end of fruits resulted less fruit drop. Similarly, the reduction in fruit drop by the spray of borax may also be due to the indirect action of boron in auxin synthesis that delayed the formation of the abscission layer during the early stages of fruit development which ultimately increases fruit retention. The current results are consistent with the findings of Singh and Singh (2015), Singh *et al.* (2016), Verma *et al.* (2016) Mayura *et al.* (2016), Kumar *et al.* (2017), Tiwari *et al.* (2017) and Abhijith *et al.* (2018) in aonla,

2. Fruit retention

The fruit retention was significantly influenced by the foliar application of calcium, zinc and boron. It is clear from the data (Table 1) that foliar application of nutrients significantly increased fruit retention (Fig.1). However, numerically maximum fruit retention (68.76 %) was recorded with treatment T_8 (Calcium chloride 1.5 % + Zinc sulphate 0.6 % + Borax 0.6 %) and minimum fruit retention (54.80 %) was noticed with treatment T_9 (control). The increase in fruit retention in aonla fruits might be due to the reason that, boron and calcium being the main constituent of the cell wall (middle lamella) of plant cell in the form of calcium pectate play an important role in the strengthening of pedicel attached to the proximal end of fruits resulted in less fruit drop. Similarly, the reduction in fruit drop by the spray of borax may also be due to the indirect action of boron in auxin synthesis that delayed the formation of the abscission layer during the early stages of fruit development which ultimately increases fruit retention. The current results are consistent with the findings of Singh and Singh (2015), Verma *et al.* (2016), Singh *et al.* (2016), Tiwari *et al.* (2017) and Tripathi *et al.* (2018) in aonla.

3. Average fruit weight (gm)

The average fruit weight was significantly influenced by the foliar application of calcium, zinc and boron. It is clear from the data (Table 1) that the foliar application of nutrients significantly increases the fruit weight (Fig. 1). The highest fruit weight (34.96 gm) was recorded in T_8 (Calcium chloride 1.5 % + Zinc sulphate 0.6 % + Borax 0.6 %). Whereas, the lowest fruit weight (26.76 gm) was recorded in T_9 (control). This increase in average fruit weight of fruits might be due to a better supply of nutrients and photosynthates in plants treated with foliar application of zinc and boron which might have made rapid synthesis of metabolites particularly carbohydrate and their translocation to the fruits causing relatively greater pulp content. The current results are consistent with the findings of Meena *et al.* (2014), Mayura *et al.* (2016), Kumar *et al.* (2017) and Tiwari *et al.* (2017) in aonla.

4. Yield per tree (kg)

The yield per tree was significantly influenced by the foliar application of calcium, zinc and boron. It is clear from the data (Table 2) that the foliar application of nutrients significantly increases the yield per tree (Fig. 1). The highest yield per tree (64.60 kg) was recorded in T_8 (Calcium chloride 1.5 % + Zinc sulphate 0.6 % + Borax 0.6 %). Whereas the lowest yield per tree (53.59 kg) was recorded in T_9 (control). The increase in yield might be due to the direct or indirect involvement of micronutrients in photosynthesis, fruit set, retention, reduction in drop as well as growth and development of fruits caused by foliar sprays of calcium, zinc and boron. These activities improve the number of fruits, length of fruits, breadth of fruits and weight of fruits and ultimately the higher yield levels. Zinc plays an important role in auxin biosynthesis which leads to a reduction in fruit drop and higher fruit retention. Meanwhile, the application of zinc and boron might have caused the rapid synthesis of protein and translocation of carbohydrates which ultimately led to an increase in average fruit weight which is directly correlated with total yield. Similar results have been reported by Meena *et al.* (2014), Chandra and Singh (2015), Mayura *et al.* (2016), Mishra *et al.* (2017) and Tiwari *et al.* (2017) in aonla.

5. Fruit yield per hectare (t)

The yield per hectare was significantly influenced by the foliar application of calcium, zinc and boron. It is clear from the data (Table 2) that the foliar application of nutrients significantly increases the yield per hectare (Fig. 1). The highest yield per hectare (17.90 t) was recorded in T_8 (Calcium chloride 1.5 % + Zinc sulphate 0.6 % + Borax 0.6 %). Whereas the lowest Yield per hectare (14.84 t) was recorded in T_9 (control). The increase in yield might be due to the direct or indirect involvement of micronutrients in photosynthesis, fruit set, retention, reduction in drop as well as growth and development of fruits caused by foliar sprays of calcium, zinc and boron. These activities improve the number of fruits, length of fruits, breadth of fruits and weight of fruits and ultimately the higher yield levels. Zinc plays an important role in auxin biosynthesis which leads to a reduction in fruit drop and higher fruit retention. Meanwhile, the application of zinc and boron might have caused the rapid synthesis of protein and translocation of carbohydrates which ultimately led to an increase in average fruit weight which is directly correlated with total yield. Similar results have been reported by Bisen *et al.* (2010) in aonla.

Table 1 : Effect of foliar application of calcium, zinc and boron on fruit drop, fruit retention and average fruit weight in aonla

Treatments	Fruit drop (%)	Fruit retention (%)	Average fruit weight (gm)
T_1 $CaCl_2$ 1.0 %	41.10	58.90	29.16
T_2 $CaCl_2$ 1.5 %	40.59	59.41	29.53
T_3 $ZnSO_4$ 0.4 %	38.35	61.65	31.08
T_4 $ZnSO_4$ 0.6 %	35.29	64.71	31.85
T_5 Borax 0.4 %	38.86	61.14	31.73
T_6 Borax 0.6 %	36.33	63.67	33.62
T_7 $CaCl_2$ 1.0 % + $ZnSO_4$ 0.4 % + Borax 0.4 %	32.88	67.12	34.11
T_8 $CaCl_2$ 1.5 % + $ZnSO_4$ 0.6 % + Borax 0.6 %	31.24	68.76	34.96
T_9 Control	45.20	54.80	26.76
SE(m) ±	0.15	0.15	0.19
CD at 5%	0.45	0.46	0.58

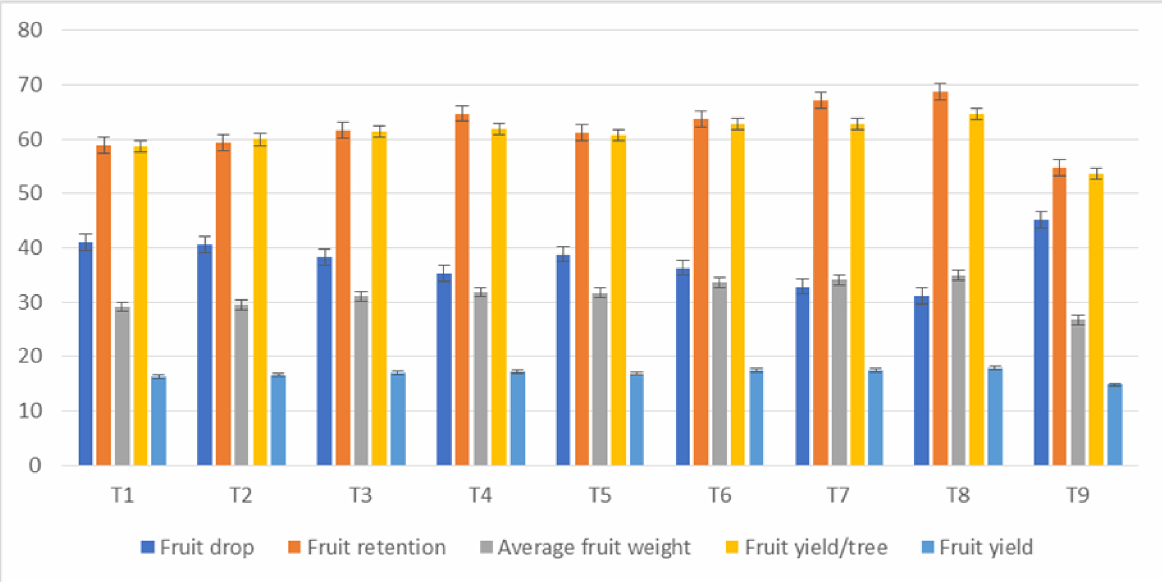

Fig. 1 : Effect of foliar application of calcium, zinc and boron on fruit drop, fruit retention, average fruit weight and yield of Aonla

Table 2 : Effect of foliar application of calcium, zinc and boron on yield in aonla

Treatments	Fruit yield/tree (kg)	Fruit yield (t/ha)
T_1 $CaCl_2$ 1.0 %	58.66	16.25
T_2 $CaCl_2$ 1.5 %	59.96	16.61
T_3 $ZnSO_4$ 0.4 %	61.48	17.03
T_4 $ZnSO_4$ 0.6 %	61.94	17.16
T_5 Borax 0.4 %	60.77	16.83
T_6 Borax 0.6 %	62.83	17.40
T_7 $CaCl_2$ 1.0 % + $ZnSO_4$ 0.4 % + Borax 0.4 %	62.86	17.41
T_8 $CaCl_2$ 1.5 % + $ZnSO_4$ 0.6 % + Borax 0.6 %	64.60	17.90
T_9 Control	53.59	14.84
SE(m) ±	0.12	0.03
CD at 5%	0.35	0.10

Conclusions

On the basis of the findings reported in the present investigation, it can safely be concluded that the application of treatment T_8 comprising Calcium chloride 1.5%, Zinc sulphate 0.6%, and Borax 0.6% is highly beneficial for the cultivation of fruit-bearing plants. The treatment, administered twice initially at the pea stage and subsequently thirty days later has been instrumental in achieving a significant reduction in fruit drop by 31.24 % and an enhancement in fruit retention to 68.76 %. Furthermore, this regimen has led to a notable increase in fruit weight averaging 34.96 grams and has markedly improved the yield per tree and per hectare to 64.60 kilograms and 17.90 tonnes, respectively. These findings underscore the potential of this treatment as a superior alternative to traditional methods, offering a promising avenue for augmenting fruit production and ensuring a more prosperous yield thereby contributing to the sustainability and profitability of the horticulture industry.

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