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Yashwant Patel
Department of Horticulture, N.D. U. A & T. Kumarganj, Faizabad, UP, India

Atul Yadav
Department of Horticulture, N.D. U. A & T. Kumarganj, Faizabad, UP, India

Bhanu Pratap
Department of Horticulture, N.D. U. A & T. Kumarganj, Faizabad, UP, India

Shivam
Department of Extension Education, N.D. U. A & T. Kumarganj, Faizabad, UP, India

Dileep Kumar Tiwari
Department of Horticulture, N.D. U. A & T. Kumarganj, Faizabad, UP, India

Correspondence
Yashwant Patel
Department of Horticulture, N.D. U. A & T. Kumarganj, Faizabad, UP, India

Effect of foliar spray of micro nutrients on yield and quality of Aonla (*Emblica officinallis* Gaertn. L.) cv. NA-6

Yashwant Patel, Atul Yadav, Bhanu Pratap, Shivam and Dileep Kumar Tiwari

Abstract
The investigation was conducted with aim to know the effect of foliar spray of micronutrients. The present investigation due to effect of foliar spray of micro-nutrients reveal that the foliar application of $CuSO_4$ (0.4%) +ZnSO4 (0.5%) was found to be most effective in reducing the intensity of fruit drop, high fruit retention, improving the fruit size and fruit weight, pulp: stone ratio, increase Vitamin-C content and highest fruit yield as compared to other treatments. Based on overall experimental findings, it may be advocated to the fruit growers in aonla fruit-belts of Uttar Pradesh for recommendation of two foliar sprays of $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%) after fruit set of aonla cv. Narendra Aonla-6 for better yield and quality of fruits.

Keywords: Aonla, fruit yield and quality traits

Introduction

The Aonla (*Emblica officinalis* Gaertn) is one of the most important indigenous fruit of India, which is also known as 'Indian goose berry belongs to family Euphorbiaceae. It is native to South- East Asia, particularly Central and South India (Morton, 1960), which is grown in India since ancient times due to its religious, nutritional and therapeutic values. It is also recognized as a 'Amritphal' and 'Wonder drug' for its significance to health, wealth and vitality. Among the sub- tropical arid fruit, aonla has potential and wider adaptability to grow under variable range of soils and agro-edaphic condition. However, the traditional cultivation of aonla predominantly is occupied in Uttar Pradesh, particular in Pratapgarh, Sultanpur, Varanasi districts. During a last decades, the commercial cultivation of aonla was expanded in almost all the states of India, because of its high nutritional values, wider adaptability and economic important. Aonla is one of the most nutritious fruit and second richest sources of vitamin c after Barbados cherry. It is also fair source of carotene, thiamine, riboflavin and carbohydrate and minerals like iron, phosphorus, calcium, and magnesium. It used for Ayuvedic medicine or processed into quality edible product. Variety of Aonla NA-6 is prolific fruit bearer. The fruit are attractive and less fibrous best for processing purpose.

Among the commercial grown varieties, NA-6 is the most popular variety among the aonla growers and also covered the maximum cultivated areas in eastern parts of Uttar Pradesh due to its high bearing potential, late fruit maturity, medium fruit size, rich in Vitamin- C content, prolonged shelf life. However, the severe fruit dropping, poor fruit yield and incidence of nutritional fruit disorders have been observed in old aonla plantation/ senile orchards, which is resulted to declining of cultivated areas in commercial fruit belts of aonla in Eastern Uttar Pradesh.

The role of micro- nutrients and plant growth regulators for improving the growth and development, fruit set, control of fruit drop, fruit maturation, fruit quality and overcoming the physiological and nutritional disorders have been well established in number of tropical, sub-tropical and temperate fruit crops (Singh *et al.* 1976, Pandey *et al*. 1986, Singh 2006 and Singh *et al*. 2007). However, it has studied the physiological biochemical and biological activities in plant systems are highly influenced due to interaction of micro- nutrients and plant growth regulators. Among the foliar application of different levels of nutrients viz., $ZnSO_4$,$CuSO_4$, $MnSO_4$, etc, have been found more effective in improving the flowering, fruit set, fruit size, fruit yield and fruit quality in number of fruit crops.

Materials and Methods

The present study was conducted on 21 years old plantation of aonla cv. Narendra Aonla-6

6 planted at Main Experiment Station, Department of Horticulture. The 21 trees having uniform growth were selected randomly from experimental block before foliar application of nutrients. The standard cultural operations and basal application of manures and fertilizers were applied as per recommended schedule for aonla plantation.

The experimental site is located at Main Experiment Station, Department of Fruit Science, College of Horticulture & Forestry, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.), on the Raibareli road at distance of which is situated under Indo-genetic plains at 26.47 N latitude, 82.12 ^{0}E longitude and altitude of 113 meter from mean sea level.

Results and Discussion

Fruiting behavior

A perusal of data recorded on per cent fruit retention shown in Table-1 reveal that there was significant response of foliar spray of micro- nutrients on better fruit retention. The maximum 25.93 per cent of fruit retention was recorded with foliar spray of micro-nutrients $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%) followed by $ZnSO_4$ (0.5%). It is evident from the results that there was high association of heavy fruit drop with poor fruit retention and low fruit drop with high fruit retention due to influence of optimum/high levels of nutrients supplemented through foliar feeding. The present finding is in conformity with observations recorded by Singh *et al.* (2001) in aonla cv. Francis, Rao *et al*. (2004) in ber cv. Banarasi Karaka, Umran, Singh *et al.* (2007) in aonla cv. N.A. 10, Shamshad *et al.*(2009) in aonla cv. Narendra Aonla- 6, Kumar and Shukla (2010) ber cv. Gola.

Data pertaining to per cent fruit drop recorded shown in Table-1 due to foliar spray of micro-nutrients at different stages of fruit development, clearly indicate that there were significant variations in per cent fruit drop. The minimum 74.07 per cent of fruit drop was recorded in treatment $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%) followed by 75.25 per cent in treatment $ZnSO_4$ (0.5%). However, the maximum 81.18 per cent fruit drop, was observed under control. The present findings are also in accordance to the observations recorded by Mansour and Sied (1981) in guava, Rani and Brahmachari (2001) in litchi cv. Purbi, Kumar and Shukla (2010) in ber cv. Gola, Singh *et al.* (2012) in aonla cv. Banarasi.

Fruit yield

The foliar spray of micro-nutrients has shown significant effect on increase in fruit yield. The highest (74.59 Kg/tree) fruit yield was obtained due to spraying of $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%) followed by (73.70 kg/tree) in $ZnSO_4$ (0.5%) as compared with other treatments while, minimum fruit yield was obtained in untreated trees. It is clear from the present findings that the yield attributing characters in aonla *viz*., Per cent fruit set, fruit retention, fruit size, fruit weight and pulp weight were significantly influenced by nutritional levels of trees, which were supplemented through foliar application of nutrients. The present finding is in conformity with the observations recorded by Khera *et al.* (1985) in citrus cv. Blood Red, Kumar *et al.* (2004) in litchi cv. Dehradun, Dutta *et al*. (2007) on guava cv. Sardar, Modi *et al*. (2012) on papaya (*Carica papaya* L.) cv. Madhu Bindu and Singh *et al.* (2012) in aonla cv. Banarasi.

Physical characters of fruit

The development of fruits size in respect to polar fruit length and fruit width is highly associated with the micro-nutrients and other metabolites. Data pertaining to fruit length showed significant variation due to foliar spray of various micro-nutrients. The maximum (4.16cm) fruit length was recorded with foliar spray of $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%) as compared with other treatments. However, significant differences were recorded in fruit width due to foliar spray of different treatments. The maximum (4.53cm) fruit width was recorded with foliar spray of $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%). Whereas, minimum fruit length and fruit width were recorded under control.

The increase in fruit size of aonla might be due to foliar spray of various micro- nutrients with Borax, Cupper sulphate, Zinc sulphate + Cupper sulphate and Zinc sulphate, which showed effect on size of the fruit. However, the beneficial effect of foliar spray of Zinc sulphate + Cupper sulphate was found better. The observations recorded in present investigations are also in accordance to studies undertaken by Kumar *et al.* (2004) in litchi cv. Dehradun, Meena *et al*. (2005) on guava cv. Sardar, Bhowmick *et al*. (2012) in mango cv. Amrapali. The similar results have also been reported by Datta *et al.* (2007) in mango cultivar Dashehari.

It is also evident from the data recorded on fruit weight due to foliar spray of different treatments that there were significant variation in average fruit weight, which ranged from 32.06 to 42.26g. The maximum (42.26g) average fruit weight was recorded due to foliar spray of $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%) followed by (40.21g) in $ZnSO_4$ (0.5%) and minimum fruit weight (32.06g) was under control. The increase in size of fruit is associated with the levels of micro-nutrients, which play an important role in development of ovary in to fruits as zinc promotes the auxin synthesis. Similar observations in respect to fruit weight have also been recorded by Dutta *et al.* (2007) on weight by potassium application in mango. Meena *et al.* (2005) on guava cv. Sardar, Singh *et al.* (2009) on phalsa, Bhowmick *et al.* (2012) in mango cv. Amrapali and Shukla *et al.* (2011) on aonla fruits 'Banarasi'.

Data pertaining to pulp: stone ratio as influenced by foliar spray of different treatments shown in Table 4.6 indicated that maximum (22.57:1) pulp: stone ratio with foliar spray of $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%) followed by $ZnSO_4$ (0.5%). Similar response was also recorded in pulp: stone ratio due to different treatments in other fruits. It is evident from the present finding that the increase in pulp weight and pulp: stone ratio in developing fruits might be due to the acceleration in biochemical activities and accumulation of metabolites in plant parts due to optimum level of nutrients status of plants. The present observation is also in accordance to observations recorded by Meena *et al.* (2005) in guava.

Singh and Brahmachari (1999) in guava cv. Allahabad Safeda, Kumar *et al.* (2004) in litchi cv. Dehradun, Meena *et al.* (2005) on guava cv. Sardar, Ghosh (2009) in aonla cv. NA-10, Singh *et al.* (2009) on phalsa fruit and Bhowmick *et al.* (2012) in mango cv. Amrapali.

Chemical characters of fruit

The observations recorded on fruit quality viz., TSS, acidity, vitamin-C, reducing sugars, non-reducing sugar and total sugars due to foliar spray of nutrients have been presented in Table-1.

A perusal of data recorded on Total Soluble Solids (TSS^{0}B) due to influence of different treatments clearly indicated that there were significant differences in TSS content. The highest (12.10) TSS was observed with spraying of $CuSO_4$ (0.4%) +$ZnSO_4$ (0.5%) followed by (12.40) in $ZnSO_4$ (0.5%). and lowest (10.13%) under control. The increase in TSS content

of aonla fruit might be due to accumulation of higher level of water soluble compounds viz, total sugars, vitamins, minerals, which were synthesized, translocated and accumulated due to chemical changes during the fruit development and maturity of fruits. The water soluble compounds in developing fruits might increase due to various levels of nutrients. The present findings are also agreement with the observations recorded in other fruits by Meena *et al.* (2005) on guava cv. Sardar, Animesh and Ghosh (2009) in litchi cv. Bombai, Shukla *et al.* (2011) on aonla fruits 'Banarasi, Modi *et al*. (2012) in papaya cv. Madhu Bindu.

Data pertaining to acidity content (Citric acid) in aonla fruit due to influence of different treatments indicated that minimum (2.02%) acidity content was observed with $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%) followed by (2.23%) in $ZnSO_4$ (0.5%). The maximum (2.80%) acidity was under control. It is apparent from the results that the reduction in acidity content due to increase the level of nutrients, sugars and other chemical compounds, which might have shown beneficial role in improving the quality of fruits by reducing the acidity content. The present observations are in conformity with findings of by Singh *et al.* (2007). In aonla cv. NA-10, Meena *et al.* (2005) on guava cv. Sardar, Bhowmich *et al*. (2012) in mango cv. Amarpali.

Vitamin-C (Ascorbic acid) content in aonla fruit is one of the prime active chemical compounds, which is significantly influenced due to endogenous nutritional status of plants and environmental factors. The observations recorded on vitamin C content in aonla cv. Narendra Aonla-6 was significantly influenced by foliar spray of different treatments. The maximum (575.50 mg/100g pulp) vitamin C content was observed with foliar spray of $CuSO_4$ (0.4%) + $ZnSO_4$ (0.5%) as compared to other treatments and lowest under control. It is evident from the result that the beneficial effect of nutrients might be due to stimulatory response of efficient synthesis and translocation of vitamin C content to the developing fruits. The present findings is also in conformity with the observations recorded by Meena *et al.* (2005) in guava cv. Sardar, Singh *et al*. (2007) in aonla cv.NA-10, Modi *et al*. (2012) in papaya fruit cv. Madhu Binduand, Shukla *et al.* (2011) in aonla cv. 'Banarasi'.

A perusal of observations recorded on per cent reducing, non-reducing and total sugars contents reveal that there was significant response to the foliar application of nutrients to increase the concentrations of reducing, non-reducing and total sugars as compared to control. The maximum reducing sugars, non-reducing sugars and total sugars were observed due to foliar spray of $ZnSO_4$ (0.5%) + $CuSO_4$ (0.4%) followed by $ZnSO_4$ (0.5%). It is evident from the present observations that the total sugars content in aonla fruit is very negligible being a non-climatic fruit, in which the synthesis of polysaccharides and their derivatives is not too much prominent due to presence of high amount of fiber content, phenolics compounds, Vitamin-C content and also lack of hydrolyzing enzymes, which inhibits the efficiency of photosynthesis. Thus, it is clear from the result that the sugars content in aonla is not much more significant chemical compounds, and which is also not much influenced by foliar application of nutrients. Similar observations were also recorded Singh *et al*. (2007) in aonla cv. NA-10, Animesh and Ghosh (2009) in litchi cv. Bombai, Singh *et al*. (2009) on phalsa fruit and Shukla *et al.* (2011) in cv. 'Banarasi'.

Table 1: Effect of foliar application of micro-nutrients on growth and yield characters of aonla.

Treatments	Fruit retention (%)	Fruit drop%	Fruit yield (kg/plant)	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Pulp stone ration	TSS (0^0 Brix)	Fruit acidity (%)	Ascorbic acid (mg/100g)	Reducing (%)	Non reducing	Total sugars
Control (water spray)	18.82	81.18	62.34	3.56	3.61	32.06	10.97	10.13	2.80	481.00	2.37	2.09	4.46
Borax (0.2%)	21.49	78.51	70.14	3.99	4.16	36.95	15.48	11.08	2.32	555.25	3.26	2.44	5.70
Borax (0.3%)	22.32	77.68	66.28	3.84	4.07	35.15	14.38	10.97	2.41	525.50	2.77	2.23	5.00
Borax (0.4%)	23.67	76.33	64.24	3.57	3.98	34.40	13.91	11.80	2.61	536.75	2.63	2.22	4.85
Zn So_4 (0.5%)	24.75	75.25	73.70	4.11	4.16	40.11	18.13	11.85	2.23	564.75	3.46	2.48	5.94
Cu So_4 (0.4%)	24.08	75.92	69.86	4.08	4.17	37.61	17.45	10.93	2.24	559.25	3.34	2.55	5.89
Cu So_4 (0.4%) + Zn So_4 (0.5%)	25.93	74.07	74.59	4.16	4.53	42.26	22.57	12.10	2.02	575.50	3.58	2.59	6.17
SEm±	0.47	0.97	1.03	0.13	0.15	1.84	1.23	0.49	0.12	5.23	0.17	0.19	0.30
CD at 5%	1.47	2.89	3.06	0.38	0.46	5.46	3.65	1.47	0.37	15.53	0.51	0.57	0.90

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