



The effect of foliar application of micro- nutrients zinc sulphate, borax, copper sulphate and calcium chloride on quality attributes of aonla

Shashank Verma^{*1}, P. N. Katiyar¹, Sandeep Kumar rajvanshi², Madhvendra singh²

¹Department of Horticulture, C.S.A.U.A.T., Kanpur, India

²Department of Applied Plant Science-Horticulture, Baba sahib Bhimrao Ambedkar University, Lucknow- 226 025, India

*e-mail: shashank3978@gmail.com

(Received: September 27, 2015; Revised received: March 24, 2016; Accepted: March 29, 2016)

Abstract: An experiment was conducted to study the effect of foliar application of micro- nutrients Zinc sulphate, Borax, Copper sulphate and calcium chloride on quality attributes of aonla cv. NA-7 during 2012-13. Among all the treatments the application of ZnSO₄ 0.1% + Borax 0.6% proved most effective inducing earliest flowering (70 days), reducing fruit drop (35.31%) and highest fruit retention (64.72%). However, the quality traits i.e. total sugar, Ascorbic acid, TSS and yield/hectare were maximized under the influence of ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1%. Whereas, all the Physico- chemical parameters studied in the present investigation were noted minimum under control.

Key words: Foliar application, Quality attributes of Aonla and Micronutrients

Introduction

The aonla (*Emblica officinalis*) synonym *phyllanthus emblica* an important minor fruit crop of commercial significance is quite hardy prolific bearer and highly remunerative even without much care. It belongs to family Euphorbiaceae. It is known as amla, amali, amlakamu and nelli in different parts of India and recognized as 'Amritphal'. It is probably the only fruit to fill the gap of astringent food recommended by Ayurvedic system of medicine for balanced diet and sound health. Aonla has great tolerance to salinity, alkalinity and sodicity. It has high value among the indigenous medicines. The fruit contains a chemical substance known as Gallic acid (polyphenol) which retards the oxidation of vitamin 'C'. It has antioxidant property, and rich source of vitamin 'C' in fresh as well as dry and processed form. Fruit is cooling laxative and diuretic. Aonla fruit contains 0.50% protein, 0.1% fat, 0.7% mineral matter, 3.40% fiber, 0.02% phosphorus, 0.05% calcium, 600 mg/100g vitamin 'C' and 81.2% moisture. The stability of ascorbic acid and presence of astringency in aonla fruit may be assigned to the presence of polyphenol or leucoanthocyanins. Aonla fruit is also valued for product like preserve (murabba), sauce, candy, dried chips, jelly, chyawanprash, pickle, powder, tophy etc. It is used for treatment of disease like dysentery (Chopra *et al.*, 1858). Aonla is native to tropical region of South East Asia particularly central southern, India. (Morton, 1960). Its wild plantation has also been

reported from Ceylon, Cuba, Hawaii, Florida, and China. It is suitable for semi arid and arid region and withstand well in salinity and drought. (Chadha, 2002). Aonla fruit is richest in vitamin 'C' after Barbados cherry. Aonla enjoys first position in minor fruits and 8th position in tropical fruits. Its coverage under U.P. is 2500 hectare. Aonla being a perennial fruit tree once planted is left for themselves, which result in several physiological abnormalities and many times it becomes difficult to diagnose them. Among the micronutrients deficiency of B, Zn, and Cu has been noticed on a very large scale and response to its application has been very spectacular. Nutrition of micronutrients has brought many fold increase in the yield of orchard and its health depending upon the severity of the deficiency. The role of Zn, Cu, and B in increasing flowering, fruit set, preventing fruit drop and improving the productivity is significant. Yellowing of cirtus, rosetting (little leaf) exanthema or dieback, fruit splitting and hardy fruits have been attributed to the deficiency of Zn, Cu and B.

The study was performed to study the effect of Boron, Zinc, Copper and Calcium on fruit drop of aonla fruits and also to find out the effect of Boron, Zinc, Copper and Calcium on Yield of Aonla.

Materials and Methods

The present investigation was made to study the effect of foliar application of Zinc Sulphate, Borax, Copper Sulphate, and Calcium Chloride on quality attributes of aonla cv. NA-7 under the agro-climatic conditions of Kanpur, Uttar Pradesh. A 12 years old

orchard of aonla located at Horticulture Garden of C. S. Azad University of Agriculture and Technology, Kanpur was selected for the present investigation during the year 2012. The experiment was laid out in randomized block design with 12 treatments *i.e.*, T₀ = Control (Water) T₁ = ZnSO₄ 0.1%, T₂ = Borax 0.6%, T₃ = CuSO₄ 0.5%, T₄ = CaCl₂ 0.1%, T₅ = ZnSO₄ 0.1% + Borax 0.6%, T₆ = ZnSO₄ 0.1% + CuSO₄ 0.5%, T₇ = ZnSO₄ 0.1% + CaCl₂ 0.1%, T₈ = ZnSO₄ 0.1% + Borax 0.6% + CuSO₄ 0.5%, T₉ = ZnSO₄ 0.1% + CuSO₄ 0.5% + CaCl₂ 0.1%, T₁₀ = ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% and T₁₁ = ZnSO₄ 0.1% + CaCl₂ 0.1% + Borax 0.6% + CuSO₄ 0.5% and three replications. The micronutrients Zinc sulphate borax, copper sulphate and calcium chloride were sprayed with their respective concentration in thrice 25 December, 25 April, 25 September. The spray solution is prepared by dissolving required amount of minerals of total quantity of 60 liters of solution for Borax, Zinc sulphate; Copper sulphate and Calcium chloride, stock solution of aforesaid minerals were prepared. The chemicals that were utilized for making different solutions were of laboratory grade reagent and demineralised water was used throughout for this purpose. Fresh solutions were prepared for each spray. Surf powder at the rate of two spoon per liter of solution was used as wetting agent. Each tree was sprayed with 10 liter of solution which was found adequate to drench entire foliage and the spraying was done in the afternoon from 4.00 P.M. To 5.00 P.M. As per schedule high volume maruti foot sprayer was used for spraying. High legged stool was used for spraying top of tree and it was fully ensured that all side of the tree was drenched completely. Polythene sheets were spread under the trees so that surplus spray drops may not reach to the soil. Observations of flowering and fruiting behavior like fruit set (%), fruit drop, Fruit retention (%) and Physical Characters like Size of fruit, Weight of fruit, Volume of fruit, Specific gravity and Chemical Characters of fruits like Total Soluble Solids (T.S.S.), Total sugar, Reducing sugar, Non-reducing sugar, Acidity, (%) Ascorbic acid, Pulp/stone ratio and yield of fruits (Sagar and Samaul, 2005; Saini *et al.*, 2001).

Results and Discussion

The data presented in the tables showed that all the parameters were influenced by the foliar spray of micronutrients. Among all the treatments the earliest flower initiation was recorded under foliar spray of ZnSO₄ 0.1% + Borax 0.6% (70.00 days) while it was delayed to maximum under control (80.00 days) maximum fruit set (51.71%) (Ei – Sherif *et al.*, 2000, Hudina and Stampar 2004) under foliar application of ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% and minimum under control 43.10% fruit set, minimum Fruit drop 35.37% under the influence of ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% (Brahmachari and Rani 2001, Ghosh *et al.* 2009, Malik *et al.*, 1990, Singh *et al.*, 2008), while maximum fruit drop under control *i.e.*, 46.93%. Foliar spray of ZnSO₄ 0.1% + Borax 0.6% was effective in greater fruit retention 64.72% (Hudina and Stampar 2004) while minimum fruit retained under control *i.e.* 53.00%.

Maximum length of aonla fruit 3.65cm were obtained under foliar spray of ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% and minimum length of fruit is 3.40cm under control. Breadth of fruit 4.91 (Jansan *et al.*, 1995)cm was obtained under foliar sprays of ZnSO₄ 0.1% +

Table -1: Monthly weather parameters recorded during 2011-12

Month	Temperature °C		Relative humidity (%)		Evap. (mm/day)	Rain fall (mm)
	Max	Min	Max	Min		
Dec. 2011	22.70	6.75	94.56	48.25	1.97	00
Jan. 2012	19.55	7.92	91.9	67.95	0.925	08.10
Feb. 2012	23.90	8.55	84.07	48.70	1.40	01.50
Mar. 2012	31.10	12.35	72.02	40.35	3.60	00
Apr. 2012	36.25	18.85	76.35	36.07	6.95	0.562
May 2012	40.25	21.53	46.65	23.16	10.86	3.00
June 2012	41.75	25.01	50.55	36.18	11.28	9.50
July 2012	37.05	27.82	84.69	69.87	9.28	106.50
Aug. 2012	34.86	26.80	89.41	71.88	4.88	125.7
Sept. 2012	31.50	25.40	88.63	67.50	3.98	114.9

Table -2: The Physico-chemical composition of soil is presented in the Experimental site during 2011- 12

Soil characteristics	Mechanical composition (%) (2012)
Sand	64.55
Silt	22.50
Clay	12.95

Borax 0.6% + CaCl₂ 0.1% and minimum breadth (Pal *et al.*, 2008) of fruit is 3.37cm under control. The trees sprayed with ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% provide most effect in improving fruit weight 37.11g (Ali *et al.*, 1993, Jansan *et al.*, 1995, Kar *et al.*, 2002) and minimum under control produced smaller fruit weight 28.53g. Foliar spray of ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% was found most effective combination in increasing the fruit volume 35.00cc (Kar *et al.*, 2002, Pal *et al.*, 2008) while minimum volume 27.06cc was recorded under control. Spray of micro-nutrients ZnSO₄ 0.1% + Borax 0.6% produced greater specific gravity 1.093 while lesser specific gravity 1.003 was recorded under control. The total soluble solids (TSS) (Nayak *et al.*, 2011, Singh *et al.*, 2008) were noted maximum (9.20°B) under the foliar application of ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% while the trees under control expressed the poorest TSS content (7.41°B) in aonla. Total sugar was recorded maximum in (8.83%) (Kar *et al.*, 2002, Singh *et al.*, 2008) under foliar application of ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% and minimum under control gave lowest value 5.90%. Reducing sugar was highest 4.80% when ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% was sprayed and minimum 3.40% under control while Non-reducing sugar was recorded maximum 3.90% when ZnSO₄ 0.1% + Borax 0.6% was applied and minimum under control 2.40%. The acidity of fruit was significantly reduced by all the treatment as compared to control (Babu *et al.*, 2001, Jansan *et al.*, 1995, Kar *et al.*, 2002). The minimum acidity 2.05% was recorded with the application of ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% and maximum under control. Foliar application of micro-nutrients ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% accumulate ascorbic acid content 589.00mg/100g (Kar *et al.*, 2002, Nayak *et al.*, 2011, Singh *et al.*, 2008, Shukla *et al.*, 2011) as compared to control with 530.00mg/100g (water spray). The pulp content 32.10g (Nayak *et al.*, 2011) was obtained under the foliar application of ZnSO₄ 0.1% + Borax 0.6% + CaCl₂ 0.1% and fruits under control gave 30.20g

Table-3: Effect of foliar spray of micro-nutrients on Flower initiation (days), Fruit set (per cent), Fruit drop (per cent), fruit retention, fruit volume (cc), specific gravity, length (cm), breadth(cm), weight(g), Total sugar (%), reducing sugar (%) and Non – reducing sugar (%) and Acidity (%)

Treat-ments	Flower initiation days	Fruit set (%)	Fruit drop (%)	Fruit retention (%)	Fruit volume (cc)	Specific gravity	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Total sugar (%)	Reducing sugar (%)	Non-reducing (%)	Acidity %
T ₀	80	43.1	46.93	53	27.06	1.003	3.4	3.37	28.53	5.9	3.4	2.4	2.51
T ₁	71	43.1	41.07	58.99	31.1	1.042	3.47	4.15	32.1	6.8	3.6	3.1	2.18
T ₂	71	44.21	36.58	63.38	30.33	1.033	3.55	4.25	32.33	6.66	3.33	3.2	2.24
T ₃	77	43.6	43.51	56.39	30.86	1.024	3.43	4.13	32.86	5.92	3	2.8	2.25
T ₄	72	45.14	41.87	58.31	31.67	1.02	3.45	4.15	32.67	6.18	3.3	2.88	2.3
T ₅	70	46	35.31	64.72	32.01	1.093	3.62	4.67	35	8.13	4.4	3.73	2.08
T ₆	77	45.16	41.8	58.03	31.83	1.006	3.45	4.15	32.83	6.03	3.2	3.63	2.38
T ₇	76	46.84	36.99	62.81	31.93	1.019	3.55	4.25	32.93	7.6	4.2	2.73	2.09
T ₈	70	47.87	38.12	61.93	32.74	1.009	3.51	4.21	33.74	7.36	3.8	3.5	2.1
T ₉	71	47.95	38.98	60.99	32.33	1.012	3.51	4.21	33.33	7.16	3.7	3.4	2.12
T ₁₀	70..00	51.71	35.37	64.24	35	1.06	3.65	4.91	37.11	8.83	4.8	3.9	2.05
T ₁₁	77	50.75	37.45	62.97	32.54	1.019	3.52	4.22	33.54	7.5	3.8	3.7	2.09
S.E.(d)	0.85	0.555	0.451	0.351	0.752	0.021	0.087	0.077	0.914	0.458	0.084	0.084	0.85
S.E.(m)	0.601	0.392	0.319	0.248	0.532	0.015	0.062	0.055	0.646	0.324	0.059	0.059	0.06
C.D.(5%)	1.774	1.158	0.941	0.732	1.57	0.044	0.182	0.616	0.907	0.956	0.176	0.176	0.178

Table-4: Effect of foliar application of micro-nutrients on Ascorbic acid (mg/100g) and TSS content, Pulp content (g), Stone weight (g), pulp stone ratio and yield (kg)

Treat-ments	Ascorbic acid (mg/100g)	TSS (°B)	Pulp content (g)	Stone weight (g)	Pulp stone ratio	Yield (kg)
T ₀	530	7.41	30.2	1.45	20.82	65
T ₁	548	7.98	31.4	1.47	21.36	72.7
T ₂	575	7.81	31.8	1.47	21.36	71.6
T ₃	532	7.55	30.4	1.46	20.82	67.6
T ₄	544	7.72	30.8	1.47	20.95	71.66
T ₅	580	8.66	32	1.23	26.01	79.25
T ₆	540	7.65	30.6	1.46	20.95	68.8
T ₇	570	8.45	31.8	1.5	21.2	78.83
T ₈	559	8.16	31.6	1.48	21.35	75
T ₉	554	8.05	31.6	1.48	21.35	74.32
T ₁₀	589	9.2	32.1	0.98	32.75	80
T ₁₁	566	8.28	31.7	1.49	21.27	76.5
S.E.(d)	8.98	0.085	0.084	0.08	1.222	0.666
S.E.(m)	6.35	0.06	0.059	0.057	0.864	0.471
C.D.(5%)	18.743	0.177	0.176	0.167	2.551	1.39

Treatments: T₀(control); T₁(ZnSO₄ 0.1%); T₂(Borax0.6%); T₃(CuSO₄0.5%) T₄(CaCl₂0.1%); T₅(ZnSO₄ 0.1%+ Borax 0.6%); T₆(ZnSO₄ 0.1%+ CuSO₄ 0.5%); T₇(ZnSO₄ 0.1%+ CaCl₂0.1%); T₈(ZnSO₄ 0.1%+ Borax 0.6% + CuSO₄ 0.5%); T₉(ZnSO₄ 0.1%+ CuSO₄ 0.5%+ CaCl₂ 0.1%); T₁₀(ZnSO₄ 0.1%+ Borax 0.6%+ CaCl₂ 0.1%); T₁₁(ZnSO₄ 0.1%+ CaCl₂ 0.1% Borax 0.6%+ CuSO₄0.5%)

pulp content. The stone weight of aonla fruit was lowest (0.98g) when ZnSO₄0.1% + Borax0.6% + CaCl₂0.1% was sprayed and maximum stone weight (1.45g) was recorded under control. The greater pulp stone (Dutta, 2004) was obtained when ZnSO₄0.1% + Borax0.6% + CaCl₂0.1% was sprayed i.e. 32.75 However, minimum 20.82 was recorded under control. Foliar application of micro-nutrients ZnSO₄0.1% + Borax0.6% + CaCl₂0.1% enhanced yields significantly 80.00 kg (Birendra Prasad *et al.*, 2005, Ghosh *et al.*, 2009, Ingle *et al.*, 1993, Khan *et al.*, 2009, Kumar *et al.*, 2010,

Yagmur *et al.*, 2002) and lowest yield 65.00kg was recorded under control. (Bajpai, 1968) reported that flower and fruit drop in aonla occurs at three stages. The first drop of flowers is the highest within three weeks of flowering due to degeneration of the egg apparatus and lack of pollination. The second drop occurs from June to September due to lack of pollination and fertilization. The third drop consists of fruits of various stages that occur from third week at august until October probably due to embryological and physiological factors. The amount of drop varied greatly with the applied micronutrients and their concentration. Regarding the retention, the foliar spray of ZnSO₄ 0.1%+ Borax 0.6% significantly increased fruit retention 64.72% followed by ZnSO₄0.1% + Borax0.6%+ CaCl₂0.1% recording 64.24%. The minimum fruit retention 53.00% was recorded under control. It was due to foliar spray of micro-nutrients Zinc and Boron which proved helpful in maintaining better nutritional status of aonla plants which ultimately led to beneficial effect in hastening fruit retention. The results are in accordance with the Sharma *et al.* (1991), Ghosh *et al.* (2009) in aonla. Shamsad *et al.* (2010), Subhashs *et al.* (2010) reported that the increase in pulp content of aonla fruits is due to feeding of micro-nutrients may be ascribed together translocation of food materials from the site of their production to the storage organs. In the present synthesis of metabolites particularly carbohydrates and their translocation to the fruits exhibiting relatively greater pulp content.

Acknowledgement

The Authors are very cooperative in nature. They help me on every stage for my research work. I am very grateful for my work.

References

- Ali, W., Pathak, R.A and Yadav, A.L.: Effect of foliar application of nutrients on guava (*Psidium guajava L.*)cv. Allahabad safeda. *prog. Hort.*, **23**: 14-21 (1993).
- Babu, N. and Singh, A.R.: Effect of foliar application of boron, zinc and copper on chemical characteristics of litchi fruits. *Bioved.*, **12**: 45-48 (2001).
- Birendra Prasad, Sudhir Das, Chaterjee, D. and Singh, U.P.: Effect of foliar application of urea, zinc and boron on yield of Guava. *J. of Applied Bio.*, **15**: 44-47 (2005).

- Brahmachari, V.S. and Rani, R.: Effect of foliar application of calcium. Zinc and boron on cracking and physico-chemical composition of litchi. *The Orissa Journal of Horticulture*, **29**: 50-54 (2001).
- Chadha, K.L.: Hand Book of Horticulture, *Pusa NewDelhi*, p.115-118 (2002).
- Chopra, R.N., Chopra, L.C., Handa, K.L.: Chpora's Indigenous Drugs of India(2nd ed.), *U.N. Dhur and Sons Pvt. Ltd., Calcutta* (1858).
- Dutta, P.: Effect of foliar boron application on panicle growth, fruit retention and physico- chemical characters of mango cv. Himsagar. *Indian j. Hort.*, **61**: 265- 266 (2004).
- El-Sherif, A.A., Sayed, W.T. and Nouman, V.F.: Effect of Foliar application $Znso_4$ on behaviour of Monta Khab D.L. Kanater Guava tree. *Bull Hort. Research Inst. Giza* (2000).
- Ghosh, S.N., Bera, B., Roy, S., Kundu, A. and Roy. S.K.D.: Effect of foliar spray of Urea, DAP, Zinc sulphate, and Borax on yield and physico-chemical composition of aonla fruits cv.Narendra Aonla-10.*Journal-of-Horticultural- sciences*, **4**: 164-166 (2009).
- Hudina, M. and Stampar, F.: Does Zinc and boron have an influence on higher yield of pears.Zbornik-referatovi-solvenskega-sadjavskera-Kongressaz-mednarodnoudalezbo-krsko-slovenia, 24-26, *Marce,Del-1*: 169-174 (2004).
- Ingle, K.G., Khan M.A.H. and Kshirsagar, R.E.: Effect of foliar application of nutrient on yield and quality on Guava.(*Psidium guajava L.*)cv.L-49. *P.K.V. Res. J.*, **17**: 78-80 (1993).
- Jansan, J.S. Singh, A.S. and P.K. Singh: Effect of various nutrients on the fruit quality of lemon. *Indian J. Hort.*, **52**: 288-290 (1995).
- Kar, P.L., Sema, A., Maiti, C.S. and Singh, A.K.: Effect of zinc and boron on fruit and quality traits in pineapple [*Annanas comosus(L.)*]. *South Indian Horticulture*, **50**: 44-49 (2002).
- Khan, Shamshad, Singh.S.K., Vishwanth and Bhanu Pratap: Effect of foliar spray of zinc sulphate, thiourea, borax on yield, size, weight, volume and fruit retention of aonla fruits.cv. Narendra Aonla-6. *Annals of Horticulture*, **2**: 83-85 (2009).
- Kumar, R., Tiwari, J.P. and Shant, Lal: Influence of zinc sulphate and boric acid spray on vegetative growth and yield of winter season guave (*Psidium guajava L.*) cv. Pant Prabhat. *J. Res.*, **8**:135-138 (2010).
- Malik, R.P.; Ahlawat, V.P. and Nain, A.S.: Effect of foliar spray of urea and zinc sulphate on growth and fruiting of Kinnow. *Haryana J. Hort. sci.*, **28**: 33-34 (1990).
- Morton, J.F.: *Eco. Bot.*, **14**: 119-128 (1960).
- Nayak, A.K., Sharma, D.K., Singh, C.S., Misrha, V.K., Gurubachan Singh and Anand Swaroopn: Diagnosis and recommendation integrated system approach for nitrogen, Phosphorus, potassium, and Zinc foliar diagnostic norms for aonla in Central Indo-Gangetic plants. *Journal of Plant Nutrition.*, **34**: 547- 556 (2011).
- Pal, Anju., Pathak, R.K., Pal, Krishna and Singh, Tejbir: Effect of breadth, weight and volume of fruits in guava (*Psidium guajava L.*) cv. Sardar. *Prog. Res.*, **3**: 89-90 (2008).
- Saini, R.S., Sharma, K.D., Dhankar, O.P. and Kaushik R.A.: Laboratory Manual of Analytical Techniques in Horticulture, *Agro bios Jodhpur (India)* (2001).
- Singh, J.K., Prasad, J., Singh, H.K. and Anshuman Singh: Effect of micro-nutrients and plant growth regulators on plant growth and fruit drop in aonla (*Emblica officinalis Gaertn.*) fruits cv. 'Narendra Aonla-10'. *Plant Archives*, **8**: 911-913 (2008).
- Shamshad Khan, Singh, H.K. Vishwanath and Suresh Kumar: Influence of foliar feeding of nutrients and thiourea on fruit yield and quality of Aonla.*Indian Journal of Fertilisers*, **6**: 8, 28-30 (2010).
- Shukla, H.S. Kumar, V. and Tripathi, V.K.: Effect of gibberelic acid and boron on development and quality aonla fruits "Banarasi". *Acta Horticulture*, **89**: 375-380 (2011).
- Subhash Yadav, Shukla, H.S. and Ram, R.A.: Studies on foliar application of NAA, GA3, boric acid, and $Ca(NO_3)_2$ on fruit retention, growth, yield and quality of aonla (*Emblica officinalis Gaertn.*) cv. Banarasi. *Horticultural Journal*, **23**: 64-67 (2010)..
- V.R. Sagar, D.V.K. Samuel: Laboratory Manual on Analysis of Fruit and Vegetable products, *I.A.R.I. New Delhi* (2005).
- Yagmur, B., Ceylan, S. and Oktay, M.: Effect of zinc fertilization of fruit yield of seedless grapes cv. Sultani *Cekirdeksiz. Ege-universitesi-ziroat, Fakultesi Dergisi*, **39**: 111-117 (2002).