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EFFECT OF CELL SIZE AND INDOL BUTIRC ACID ON PLUG TRANSPLANT QUALITY IN RELATION TO STRAWBERRY PRODUCTIVITY

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ABSTRACT:

This study was conducted at El-Kanater El-Khiria Horticulture Research Station, Qaluobia Governorate in the two successive seasons of 2010/2011and 2011/2012The experiment was carried out to develop a syste m for producing of good quality strawberry plug transplants in Egypt in addition to its subsequent effect on productivity and quality of Festival strawberry cultivar. Three cell sizes (150, 50 and 25, 5 ml) and three concentrations of indol butirc acid (IBA) (0, 250 and 500 ppm) were used. After one month, plug transplants were taken and then planted for fruit production to study the effect of such treatments on earliness of flowering, yield and quality. The results indicate that the highest numbers of roots, root length and crown diameter were detected to cells with 150 ml in the two tested seasons. Root length increased using 500 or 250 ppm IBA. The highest early and total yields were recorded when using of the largest size of cells, i.e. 150 ml. Significant increments in the earliness of flowering when transplants were treated with IBA at all concentrations compared with the traditional bare root ones (control) during the two tested seasons.

Key words: *Strawberry, cell size, indol butirc acid, vegetative growth, yield*

الملخص

أجريت هذه الدراسة لدراسة تأثير حجم عيون الزراعه وأندول حمض البيوتريك على جودة الشتلات الناتجة والإزهار والمحصول فى الفراوله وأشتملت الدراسة على تجربتين على النحو التالى :-

التجربه الأولى (التجذير)

أجريت التجربة اجريت هذه التجربة لإيجاد الطريقة المثالية لأنتاج شتلات الفراولة المجدرة تحت الظروف المصرية وخصوصآ تأثير حجم عيون الزراعة ، و أندول حمض البيوتريك على جودة الشتلات الناتجة. حيث تم أخذ الشتلات من المشتل المعلق فى منتصف سبتمبر وزرعت فى صوانى الزراعة (84 عين).

التجربه الثانيه (تأثير المعاملات السابقة على مواصفات الشتلات)

أجريت التجربة فى المزرعة البحثية لمعهد بحوث البساتين بالقناطر الخيرية بمحافظة القليوبية خلال الموسمين 2011/2010 و 2010/2011 لدراسة تأثير نفس المعاملات السابقة (3 أحجام لعيون الزراعه – 3 تركيزات لأندول حمض البيوتريك) بالمقارنة بالشتلات الملش الناتجه من المشتل المفتوح على التزهيروالمحصول وجودة الثمار حيث زرعت النباتات

فى أرض الإنتاج.

وقد أظهرت النتائج المتحصل عليها -:

1. بالرغم من عدم وجود فروق معنوية بين المعاملات فى الموسم الأول إلا إنه سجل الحجم 150مل أعلى القيم لطول الجذور بدون فرق مع الكنترول.
2. اعطت الصوانى ذات 84 عين اقل سمك للتاج للشتلات بينما لم يكن هناك فرق بين الاحجام 150، و50 مل والكنترول .
3. زاد طول الجذور باستعمال التركيزين 250، و500ppm من IBA بالمقارنة بالكنترول فى الموسم الاول بينما لم تؤثر المعاملات فىهذة الصفة الموسم الثانى
4. لوحظ وبشكل ملحوظ التزهير المبكرللنباتات المجدرة(ذات الصلايا) عموماً بالمقارنه بالشتلات المالش حيث أزهرت النباتات بعد 33 ,58 يوم والنباتات الناتجة من الزراعة فى اوعية بحجم 150 ، و 50 مل فى الموسم الأول 52.75 ، و 55.50 يوم على الترتيب خلال الموسم الثانى.
5. سجل اعلى محصول مبكروكلى من استخدام عيون زراعة كبيرة وكانا 156.68 ، و 176.82 جم/للنبات للمحصول المبكر خلال الموسم الأول و الثانى على الترتيب547.32 ، و 587.69 جم/نبات للمحصول الكلى خلال الموسمين على التوالى.

INTRODUCTION:

The availability of high quality plants is one of the most important factors in obtaining good yield. Most of the strawberry production areas in Egypt are planted with bare-root transplants which are relatively inexpensive and provide high yield but they need high water quantities for transplant establishment. However, also they are often not uniform in size, and are difficult to be established under high temperatures in fall months **(Bish *et al*., 1997)**.Strawberry yield is affected by vigor and disease free transplant **(Cocco *et a*., 2010)**. To ensure production of pathogen and nematod free transplants, the soil of the nurseries shoud be fumigated prior to planting with methyle bromide (MB). An alternative method for the production of clean strawberry transplants is that known as plug plant **(Fumiomi Taked *et al*., 2004). Daniel *et al.* (2010)** concluded that strawberry plug planting system is excellent method for establishing plants and provide appropriate levels of vegetative vigor for successful harvests.

As for cell size effect, **Fumiomi and Hokanson (2000)** conducted an experiment on two cell sizes viz., 0.8 L and 1 L,they reported that greater fruits were obtained with 1L in December and January and flowered two weeks earlier. Also, **Eric *et al.* (2002)** reported that plants propagated in the 150 cm^3 and 300 cm^3 containers gave the highest early yield while no significant differences were detected between the three sizes (75, 150 and 300cm^3) with respect to total yield . **Kirk *et al*. (2002)** found that there was significant effect for cell size on early yield. In addition, large plugs had greater total yield than smaller plugs. **Gustavo *et al.* (2009)** found that early fruit yield did not differ among plug transplant treatments (cell size) with an average of 460 g per plant and was higher than in bare root transplants.

As respect to the effect of Indol butric acid (IBA), **Santelices (2007)** stated that the root length is directly proportional to the concentration of IBA. The increased root length with application of IBA could be explained by the ability of auxin to decrease the rigidity of the cell wall by acidifying the same, which causes the production of proteins that are also involved in cell wall acidification causing cell growth to increase its volume **(Taiz and Zeiger, 2010).**

Plug transplants are characterized by quickly establishment have a survival rate of almost 100%, reduced risks of soil borne diseases, reduced pesticide cost. Information on plug

propagation system under Egyptian condition are stile limited and its effect on productivity and fruit quality are, also, lacking.

Therefore, the objectives of this work were to study the effect of Indol butric acid and cell size on strawberry plug transplants quality in Egypt, besides the evaluation of their effect on subsequent productivity and fruit quality.

MATERIALS AND METHODS

This study was carried out to study the effect of the cell size and concentration of IBA on quality of transplants to produce strong vegetative growth and rooting system and to determine growth, development and fruit yield of festival strawberry plants from plug transplants compared to bare root transplants as control. The study was conducted in two experiments (rooting stage-evaluation in fruit production field) as follows:-

1- FIRST EXPERIMENT:-

This experiment was conducted in a private farm at Ismailia Governorate to study the effect of the cell size and concentration of IBA on quality of transplants to produce strong vegetative growth and rooting system for plugs. Daughter plants were removed from soilless runners at 15th August and treatments consisted of plug daughter plants produced in trays with cell volumes of 25.5, 50 and 150 cm^3. They were planted in cell trays filled with peat moss, vermiculite and perlite medium in vegetable transplant production. As for Indol butric acid (IBA), transplants were soaked in solution of Indol butric acid (IBA) for 20 min. before transplanting. Butric acid solution was dissolved in 0, 2.5 and 5.0 g of buric acid in one litter of distillated water which represent 0, 250 and 500 ppm.The trays were placed under micro- sprinklers (mist) irrigation under shad house. After four weeks, transplants were randomly selected from each replicate were also used from plug transplants and bare root transplants (from open nursery).

Data were recorded on random samples of ten transplants from each experimental plot in mid-September (transplant harvest date) to determine the number of leaves,roots, roots length and crown diameter of transplants. The experimental design was complete randomized design with four replicates

2-SECOND EXPERIMENT:-

This experiment was conducted at El-Kanater El-Khiria Horticultural Research Station, Qaluobia Governorate to study the performance of transplant produced from three cell sizes and Indol butric acid consternation in addition to bare root transplants obtained from open field nursery produced from the first experiment as earliness of flowering, quality of fruits and yield. Planting dates were September 15^{th} and 17^{th} in the first and second seasons, respectively. The soil was clay with Ec.665 and pH 98. A complete randomized block design with four replicates was adopted. Four rows bed system was used. Each replicate consisted of two beds with 80 plants, 120 cm width, and 50 cm height; at plant distances of 25 cm between plants and 30 cm between the four rows. The drip irrigation was taken place and after one month beds were mulched with 40 micron of double face black silver mulch.

The agricultural practices concerning cultivation, fertilization, irrigation and pest- and disease- control were conducted as commonly followed as the recommendation of ministry of agriculture for the commercial production of strawberry.

The data were recorded as follows:

Representative samples of plug transplants and bare root were taken to record the vegetative growth characteristics i.e. number of leaves\plant, plant length, crown diameter, number of roots and root length of transplants were determined as the method described by **A.O.A.C (1990).** Earliness of flowering as number of the days from planting to beginning of flowering were recorded. Early yield as weight of all harvested fruits from each plot during the first five harvests (January and February) and average early yield per plant was calculated.Total yield as the weights of all harvested fruits all over the season from each plot to calculate the average total yield per plant. Also average fruit weigh and fruit firmness determined by using a Shatillon Penetrometer **(Qurecky and Bourne, 1968).** Total soluble solids content (TSS) using the hand refractmeter were determined. Moreover, titratable acidity (TA), pH and Ascorbic acid content were determined as the method mentioned in **A.O.A.C. (1990).**

Statistical analysis

All data were subjected to analysis of variance with SAS statistical package (SAS, 1998). Means were separated using Duncan's multiple range tests **(Waller and Duncan, 1969)**.

RESULTS AND DISCUSSION

A- FIRST EXPERIMENT:-

1. Effect of cell -tray size on number of transplant leaves

Data in Table (1) showed that daughter plants obtained from the soilless nursery technique in all cell transplants trays grew vigorously and gave higher number of leaves per transplant, without significant difference among them, compared with the traditional bare root transplant obtained from the open field (control), during the two studied seasons.These results agree with those reported by **Hochmuth *et al.*, (2006a**),who reported that plug plants had greater leaf number.

Table (1): Effect of cell -tray size on strawberry transplant characters in 2010 and 2011 seasons.

Cell tray size	Number of leaves		Number of roots		Root length(cm)		Crown diameter (cm)	
	2010	2011	2010	2011	2010	2011	2010	2011
150 ml	5.22 a	5.72 a	23.38 a	23.87 a	12.83 a	12.00 a	0.84 a	0.82 a
50 ml	5.16 a	5.33 a	23.38 a	23.88 a	12.61 a	9.67 b	0.80 a	0.81 a
25.5ml	4.66 a	5.16 a	22.66 a	23.06 a	12.56 a	9.61 b	0.67 b	0,68 b
Control	3.66 b	4.16 b	23.24 a	23.92 a	12.55 a	11.20 a	0.78 a	0.79 a

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range tests at 5% level. Control= Bare root traditional production method

2. Effect of cell -tray size on number of roots transplant

Data presented in Table (1), clearly, indicated that there were no significant differences in number of transplant roots among all tested cell-tray sizes and bare root transplants obtained from the open nursery (control) during the two studied seasons. This result may be due to the success of rooting depends on various factors one of them is the growing media as reported by **Treder *et al*. (2014**).

3. Effect of cell -tray size on root length of transplant

As shown in Table (1), there were no significant differences in transplant root length among all tested cell-tray sizes and bare root transplant obtained from the open nursery (control) during the first season. The non significant difference in cell tray transplants and traditional bare root production method may be due to that the success of rooting depends on various factors as reported **Treder *et al*. (2014**). On the other hand, data showed that cell-tray size of 150 ml gave the highest root length without significant difference between it and bare root transplants obtained from the open nursery (control) during the second season. On the other side, the lowest value of transplants roots length was noticed with 50 ml and 25.5 ml cell-trays size in the second season.

4. Effect of cell -trays size on transplant crown diameter

Data in Table (1) indicated that the transplant crown diameter was higher when using 50 and 50 ml cell-tray sizes and bare root transplants obtained from the open nursery (control) without significant differences among them during the two tested seasons. These results agree with those reported by **Gustavo *et al*. (2009)** who found that bare root transplants and plug transplants from large cell size had larger crown.

Data also, showed that the cell-tray sizes 50 and 150 ml and bare root transplants (control) produced good crown diameter nearly 8 mm that could be one of the parameters taken in consideration for screening the physiological quality of strawberry transplants as reported by **Hochmuth *et al*., (2006b).**

The obtained results are in agreement with those reported by **Cocco *et al.* (2011),** who mentioned that the strawberry crown diameter was higher in plug transplants. On the other hand, transplants planted in 25.5 ml cell size gave the lowest significant mean values of transplant crown diameter, in the two tested seasons.

5. Effect of IBA treatment on number of transplants leaves.

Data in Table (2) showed that the application of IBA did not increase the number of leaves per transplant in the two tested seasons. In addition, IBA at 500 ppm decreased the leaf number.However, the lowest mean values of number of leaves were registrated in control transplants. This result may be due to that IBA promotes root growth but not necessarily shoot growth.

Table (2): Effect of IBA on some plug strawberry transplant characters during the two studied seasons.

IBA	Number of leaves		Number of roots		Root length(cm)		Crown diameter (cm)	
	2010	2011	2010	2011	2010	2011	2010	2011
Without	5.22 a	5.72 a	33.66 a	22.61 b	13.16bc	9.50 b	0.81 a	82.00 a
250 ppm	5.00 ab	5.50 ab	32.11 a	34.51 a	13.73ab	9.28 b	0.81 a	82.00 a
500 ppm	4.78 b	5.28 b	23.42 b	32.61 a	14.33 a	8.61 b	0.83 a	84.00 a
Control	3.66 c	4.16 c	21.44 b	23.92 b	12.55 c	11.20 a	0.78 a	79.00 a

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range tests at 5% level.
Control= Bare root traditional production method

6. Effect of IBA on number of roots of transplants

Data in Table (2) showed that application of the plug transplants by 250 ppm IBA gave the highest values in this character without significant between it and those un treated with IBA during the first season. Moreover, in the second season the highest values were detected to 250 and 500 ppm IBA. In other words application of IBA at 250 ppm was the best treatment in the two seasons. This result may be due to that IBA applications promote adventitious root formation in transplants, which increases root growth as reported by **Hartmann *et al.* (2010)**.

These results agree with those reported by **Roh *et al.* (2005)** who observed that the application of IBA increased the rooting percentage compared with un trated of IBA plants.

7. Effect of IBA on root length of plug strawberry transplants

The results presented in Table (2), clearly indicated that root length increased by using 500 ppm or 250 ppm IBA as compared with control transplants, in the first season. However, indol butric acid decreased the root length, in the second season, compared to control treatment.

These results may be due to that the success of rooting depends on various factors not only IBA but also on growing media, cultivar and air humidity as reported by **Treder *et al*. (2014**). These results did not agree with those reported by **Hartmann *et al.* (2010**) and **Santelices (2007)**

8. Effect of IBA on crown diameter of transplant

There were no significant differences in crown diameter of plug transpants among all tested treatments, as a result of IBA application in the two tested seasons (Table 2).

B- SECOND EXPERIMENT:-

1. Effect of cell tray size on flowering.

The cell -tray sizes at 150 and 50 ml produced significantly the early flowers than the transplants producted in 25.5 ml or bare root transplants during the two studied seasons (Table 3).These results could be due to the increment of crown diameter in the strawberry transplants from the cell -tray sizes at 150 and 50 ml which gave a good indicator of plant growth when transplanting in the field. These results agree with those of **Fumiomi *et al*. (2004)** and **Cocco *et al*. (2010).**

Table (3): Effect of cell trays size on earliness of flowering and early and total yield during 2010\2011 and 2011\2012 seasons.

Cell trays size	Earliness of flowering		Early yield (g/plant)		Total yield (g/plant)	
	2010/2011	2011/2012	2010/2011	2011/2012	2010/2011	2011/2012
150 ml	48.00 b	45.50 b	156.68 a	176.82 a	547.32 a	587.69 a
50 ml	53.33 ab	43.25 b	155.60 ab	176.58 ab	528.97 a	569.02 b
25.5 ml	58.33 a	55.50 a	154.82 b	175.60 bc	522.44 c	562.53 bc
Control	58.33 a	52.75 a	146.64 c	176.82 c	523.38 bc	563.78 c

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range tests at 5% level Control = bare root transplant

These results agree with those reported by **Hochmuth *et al*. (2006a)** who concluded that plug transplants had earlier flowering. This result may be due to the plugs have the root system embodied by the substrate and have advantages in relation to crop stand, and disease and pest management as reported by **Hochmuth *et al*., (2006b**).The obtained results showed that there was delaying of flowering in the traditional bare root transplants (control) when transplanting in field. These results may be due to the mechanical damage to the root system at planting and high risk of contamination by pathogens in bare root plants as reported by **Durner *et al*., (2002)**.

2. Effect of cell tray sizes on early and total yield.

Data in Table (3) indicated that the early and total fruit yields were affected by cell -tray sizes.The increasing of transplants cell tray size lead to significant increase in early and total yield of plug transplant system than the traditional bare root transplants. This result could be due to the increment in the earliness (low number of days from planting to flowering) in plug transplants as shown in Table (3) which directly increased early yield .The result indicated also that the use of 50 and 150 mm cell size of trays is advantageous for commercial production due to producing the highest early and total fruit yields while the use of 25.5 mm cell size and traditional bare root transplants gave the lowest early and total yields during the two studied seasons. These results agree with those reported by **Hochmuth *et al*., (2006b)**

This result could be due to earliness of flowering in strawberry transplants from the large cell trays transplants as shown from previous results in (Table 1) which directly increased the early and fruit yield as reported by **Cocco *et al* (2011)**.

3. Effect of cell tray sizes on average fruit weight and fruit firmness

Data presented in Table (4) showed that the cell-tray size did not affect significantly average fruit weight and fruit firmness compared with the traditional bare root transplants (control) in strawberry plants during the two studied seasons.

Table (4): Effect of cell tray sizes on fruit weight and firmness during 2010\2011 and 2011\2012 seasons.

Cell trays size	Average fruit weight (g)		Fruit firmness (g/cm^2)	
	2010/2011	2011/2012	2010/2011	2011/2012
150 ml	20.47 a	22.64 a	500.00 a	500.00 a
50 ml	17.67 a	19.90 a	500.00 a	500.00 a
25.5 ml	17.45 a	19.60 a	483.33 a	500.00 a
Control	21.05 a	23.28 a	500.00 a	500.00 a

Values in the same column followed by the same letter do not significantly differ from each other according to Duncan's multiple range tests at 5% level. Control = bare root transplant

4. Effect of cell tray sizes on fruit chemical characteristics

Data presented in Table (5) showed that the cell-trays size did not affect significantly the fruit chemical characteristics, i.e., total soluble solids, pH value and ascorbic acid content compared with the traditional bare root transplants (control) in strawberry plants during the two studied seasons. In this connection, the cell-tray transplant size at 150 ml gave the significant increment in the titratable acidity in strawberry fruits in the second season only.

Table (5): Effect of different cell -trays size on fruit chemical characteristics during 2010\2011 and 2011\2012 seasons.

Cell trays size	Total soluble solids (%)		Titratable acidity (mg/100g)		pH value		Ascorbic acid content (mg/100g f.w)	
	2010/2011	2011/2012	2010/2011	2011/2012	2010/2011	2011/2012	2010/2011	2011/2012
150 ml	9.66 a	9.45 a	0.28 a	0.30 a	4.43 a	3.22 a	84.79 a	86.29 a
50 ml	9.50 a	9.28 a	0.29 a	0.28 b	4.47 a	3.40 a	84.89 a	86.35 a
25.5 ml	9.00 a	9.17 a	0.29 a	0.28 b	4.50 a	3.49 a	84.75 a	86.25 a
Control	8.39 a	9.39 a	0.28 a	0.28 b	4.40 a	3.32 a	85.43 a	86.93 a

Values in the same column followed by the same letter do not significantly differ from each other according to Duncan's multiple range tests at 5% level. Control = bare root transplant

1. Effect of IBA concentration on earliness of flowering.

Data in Table (6) indicated significant increments in the earliness of flowering when transplants were treated with IBA at all concentrations compared with the traditional bare root ones (control) during the two tested seasons. At the same time, data indicated that plug transplants which were not treated with IBA lead also to significant increments in the earliness compared to bare root when transplanting in field without significant differences between it and these the treated by IBA.

These results could be due to the increments of the number and length of transplant roots in plug transplants that treated by IBA as shown in Table (2). The increments of the number and

length of strawberry transplants roots lead to protect the transplants after planting from mechanical damage by the substrate remaining attached to the roots. Therefore, their initial growth after planting is enhanced, leading to early flowering. These results in agreement with **Hochmuth *et al*. (2006a) and Durner *et al*. (2002**)

Table (6): Effect of IBA concentration on earliness of flowering, early and total yields during 2010\2011 and 2011\2012 seasons.

IBA	Days to flowering		Early yield (g/plant)		Total yield (g/plant)	
	2010/2011	2011/2012	2010/2011	2011/2012	2010/2011	2011/2012
Without	52.67 b	53.00 b	155.60 a	185.72 a	583.38 a	573.78 a
250 ppm	52.67 b	51.33 b	155.38 a	176.82 b	562.84 b	502.79 c
500 ppm	51.00 b	53.33 b	145.51 b	175.51 b	534.50 c	544.73 bc
Control	58.33 a	56.33 a	146.64 b	176.82 b	523.37 d	563.78 d

Values in the same column followed by the same letter(s) do not significantly differ from each other according to Duncan's multiple range tests at 5% level. Control = bare root transplant

2. Effect of IBA concentration on early and total yield.

It appears from data in Table (6) that the un treated plug transplants followed with those soaked in IBA at 250 ppm increased significantly the early and total yield, in general, compared with the traditional bare root method (control) during the two studied seasons. On the other hand, the obtaind results showed also that control plants gave the lowest total yield in two tested seasons.

3. Effect IBA concentration on average fruit weight and firmness.

Data presented in Table (7) showed that treating or non treated plug strawberry transplants with IBA did not affect the fruit firmness during the two studied seasons as compared with the traditional bare root plants (control) in strawberry plants. While average fruit weight was slightly affected by tested treatments. Control treatment showed the lowest value in two tested seasons.

Table (7): Effect of Effect of IBA concentration on average fruit weight and firmness during 2010\2011 and 2011\2012 seasons.

IBA	Average fruit weight (g)		Fruit firmness (g/cm^2)	
	2010/2011	2011/2012	2010/2011	2011/2012
Without	22.51 ab	21.98 a	500. 00 a	500.00 a
250 ppm	23.70 ab	22.99 a	500. 00 a	500.00 a
500 ppm	26.05 a	25.01 a	500. 00 a	500.00 a
Control	21.05 b	19.05 b	494.44 a	500.00 a

Values in the same column followed by the same letter do not significantly differ from each other according to Duncan's multiple range tests at 5% level. Control = bare root transplant

4. Effect of IBA concentration on fruit chemical characteristics.

Data presented in Table (8) showed that IBA application did not affect the fruit total soluble solids, titratable acidity and ascorbic acid contents during the two studied seasons.As for pH value, data in Table (8) showed also that using IBA slightly affected the fruit pH in two tested years.

Table (8): Effect of IBA concentration on fruit chemical characteristics during 2010\2011 and 2011\2012 seasons.

IBA	Total soluble solids (%)		Titratable acidity mg/100g		pH Value		Ascorbic acid content (mg/100g f.w)	
	2010/2011	2011/2012	2010/2011	2011/2012	2010/2011	2011/2012	2010/2011	2011/2012
Without	8.28 a	9.27 a	0.29 a	0.30 a	4.49 ab	3.51 ab	85.07 a	86.57 a
250 ppm	8.22 a	9.19 a	0.28 a	0.31 a	4.37 b	3.39 b	84.79 a	86.29 a
500 ppm	8.33 a	9.31 a	0.29 a	0.30 a	4.57 a	3.59 a	85.64 a	87.14 a
Control	8.39 a	9.37 a	0.28 a	0.30 a	4.40 b	3.42 ab	85.43 a	86.93 a

Values in the same column followed by the same letter do not significantly differ from each other according to Duncan's multiple range tests at 5% level. Control = bare root transplant

REFRENCES

- **Association of Official Agricultural Chemists (A.O.A.C). (1990).** Methods of analysis, 15th edition, Washington D.C., USA.
- **Bish, E.B.; D.J. Cantliffe; G.J. Hochmuth and C.K. Chandler (1997).** Development of containerized strawberry transplants for Florida's winter production system. Proc. Third. Intl. Strawberry Symp. Acta Hort. 439:461–468.
- **Cocco C.; J. L. Andriolo; L.Erpen; F.M. Cardoso and G.S. Casagrande . (2010).** Development and fruit yield of strawberry plants as affected by crown diameter and plantlet growing period. Pesqui Agropecu Bras. 45(7): 730–736.
- **Cocco C., J. L.; Andriolo.; F. L. Cardoso.; L. Erpen and O. J. Schmitt (2011).** Crown size and transplant type on the strawberry yield. Sci. Agric.(Piracicaba, Braz.). 68 no.4 piracicaba July/August.2011.
- **Daniel R.; B. Black and D. Drost (2010).** Strawberry plug production. Horticulture Utah state University Cooperative Extension January 2010.
- **Durner E.F.; E .B. Poling and J. L. Maas (2002).** Recent advances in strawberry plug transplant technology. HortTechnology. 12: 545–550.
- **Eric B. B.; D. J. Canttiffe and C. K. Chandler (2002).** Temperature conditioning and container size affect early season fruit yield of strawberry plug plants in a winter, annual hill production system Hort. Since 37(5) 762-764.2002
- **Fumiomi T., and S. C. Hokanson (2000).** Effect of transplant conditioning on Chandler strawberry performance in a winter greenhouse production system. Acta Abstract

- **Fumiomi Taked.; S. C. Hokanson and J. M. Enns. (2004).** Influence of doughter plant weight and position on strawberry transplant production and field performance in annual plasticulture. Hortscience. 39 (7) 1592-1595 (2004).
- **Gustavo G.; J. L. Andriolo; D. Janisch; C. Cocco and M. D. alzpicio (2009).** Cell size in trays for the production of strawberry plug transplants. Pesq. Agropec. Bras. 43 (12) Brasilia Dec. 2009
- **Hartmann, H.T.; D.E. Kester; F.T. Davies; and R. Geneve (2010).** Hartmann & Kester's plant propagation: principles and practices. 8th ed. Prentice Hall, Englewood Cliffs, NJ.
- **Hochmuth G.; D. Cantliffe; C. Chandler; C. Stanley; E. Bish.; E. Waldo; D. Legard; and J. Duval (2006b).** Fruiting responses and economics of containerized and bare root strawberry transplants established with different irrigation methods. HortTechnology, 16: 205-210.
- **Hochmuth G.; D. Cantliffe; C. Chandler; C. Stanley; E. Bish. and E. Waldo. (2006a).** Containerized strawberry transplants reduce establishment-period water use and enhance early growth and flowering compared with bare root plants. HortTechnology, 16: 46–54.
- **Kirk D. L.; E. P. Elizabeth and V. S. Douglas (2002).** Containerized strawberry transplnts as replacement for methyl bromide soil fumigation in California straberry nurseries. Acta Abstract
- **Qureck, D.K.; and M.C. Bourne. (1968).** Measurement of strawberry texture. J. Amer. Sci. 93:317-325.
- **Roh, M.S.; A. K. Lee; and J. K. Suh (2005).** Production of high quality Ardisia plants by stem tip cuttings. Sci. Hortic. 104, 293-303. Doi: 10.1016/j.scienta.2004.09.001
- **Santelices, R. (2007).** Efecto del ácido indolbutírico (AIB) y la presencia de hojas en el arraigamiento de estacas de Nothofagus glauca (Phil.) Krasser cosechadas en dos épocas diferentes. Ecol. Austral 17, 151-158.
- **Taiz, L. and E. Zeiger. (2010).** Plant physiology. 5th ed. Sinauer Associates, Sunderland, MA.
- **Treder, w.; G. A.Tryngiel; K. Klamkowski and A. Masny (2014).** Evaluation of efficiency of a nursery system for production of strawberry potted plants in protected condition. Polska Akademia Nauk, Oddział w Krakowie, s. Nr IV/3/2014, 1333–1341.
- **Waller, R. A. and D. B. Duncan (1969).** A Bayes rule for the symmetric multiple comparison problems. J. Amer. Static. Assoc., 64:1485-1503