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Physiological Studies on Pre-Rooting Cold Storage and Some Rooting Stimulants on Chrysanthemum Quality

A-Main Effect of Pre-Rooting Cold Storage Periods and Some Rooting Stimulants.

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ABSTRACT

This experiment was carried during 2013/2014 and 2014/2015 seasons to determine the greatest period of tolerance for storage periods at low temperature (4° C±2) of chrysanthemum cuttings (*Dendranthema grandiflora,* Tzevlev) var. "Looding" , without any loss in the rooting percentage and the quality of the roots formed and vegetative growth and flowering parameters. Also, to investigate the best level of IBA, NAA and root fast for chrysanthemums. All treatments of storage period (one month : three month) significantly increased the rooting, vegetative growth and flowering parameters, total chlorophyll, total nitrogen and total carbohydrates than cold storage for 4 month at 4 C^0 treatment, in the two seasons. The parameters mentioned above were gradually decreased by the extending of the cold storage periods, i.e. 2, 3 and 4 month at 4 C^o, in both seasons. Storage of non-rooting cuttings of chrysanthemum for one month significantly increased most parameters as compared to control treatment in the two seasons. The non-rooted cuttings of chrysanthemum were dipped for 10 min. in all auxin concentrations (IBA, NAA and root fast) used in this study significantly increased all parameters as compared to control treatment in the two seasons. The highest concentration of IBA (1000 ppm) surpassed significantly other rooting stimulants concentrations. The increased root fast concentration treatments improved parameters under this study.

Keywords: Chrysanthemum (*Dendranthema grandiflora,* Tzevlev) var. "Looding", non rooting cuttings, IBA, NAA, Root Fast, Storage, Vegetative growth.

INTRODUCTION

Chrysanthemum *(Dendranthema grandiflora,* Tzevlev) var. "Looding" belongs to Family Asteraceae. Flowers occupy an important position in the local and foreign markets because of their beautiful shape and longevity in vases. It is highly attractive and charming short day plant, which behaves both as an annual as well as perennial flowering herb (Arora, 1990). Chrysanthemum is one of the most common cut flowers and of the highest economic importance in the floriculture industry for decoration and adornment *Chrysanthemum morifolium* is a perennial herb grown well in Egypt as one of the most important cut flowers and pot plants. Chrysanthemum is vegetatively propagated (Verma *et al.,* 2009 & Verma, 2012).

Short-term post-harvest storage of cuttings allows cutting producers to regulate the market supply during surplus production or peak demand to help accommodate propagation and production schedules (Lopez and Runkle, 2008). However, cuttings can deteriorate with extended storage period due to excess respiration, light exclusion, exposure to extreme temperatures, moisture loss, pathogen invasion, and ethylene (Rapaka *et al*., 2007). The exact influence of storage on rooting has not been widely investigated, storage in a cold chamber has long been known to be a good procedure for preserving carnation cuttings intended for rooting (Garrido *et al*., 2003). The survival and rooting rates of herbaceous and woody ornamental species can be influenced by environmental conditions during shipping and storage (Druege *et al*., 2000). The genetic properties of cold storage materials and conditions had effects on suitable cold storage duration. The duration and the temperature of cold storage vary according to the plant species and variety being stored (Nowak *et al.*, 1990). Non-rooted carnation cuttings can be stored for 6 months at 0°C according to Gürsan (1986).

The important role of auxins includes stimulation of cell division, cell enlargement, cell elongation, continue growth of callus, differentiation of cells in callus, root formation on cuttings, stem elongation as well as synthesis of RNA, enzymes, protein and cell wall components. It is well known that the success of rooting of woody stem cuttings, in the majority of ornamental plants and fruit trees depends mainly on the physiological stage of the mother plant, the time of planting of the cutting and the type of growth regulators used (Day and Loveys, 1998 and Darwesh, 2000). Auxin is well-known to stimulate the rooting of cuttings (Hartmann *et al*., 2002). However, the most widely used auxin for commercial rooting is IBA (Nickel, 1990). Today, IBA and NAA are still the most widely used auxins for rooting stem cuttings. It is well known that auxins are required for adventitious roots initiation on stems and it has shown that divisions of the first root initial cells are dependent upon either applied or endogenous auxins (Gaspar and Hofinger, 1988). The formation of root primordial cells depends on the endogenous auxins in the cutting and on a synergic compound such as a diphenol. These substances lead to the synthesis of ribonucleic acid (RNA), which act upon root primordial initiation (Hartmann *et al.,* 2002).

Chrysanthemums are commercially propagated through cuttings. Pre-rooting storage of cuttings in the dark is a common practice among growers and companies that work and trade with chrysanthemum cuttings. Therefore, the aim of this study was to determine the maximum period of tolerance for storage periods at low temperature ($4C^o$) for cuttings chrysanthemums without their being any loss in the rooting percentage, the quality of the roots formed, vegetative growth and flowering parameters. To investigate also the optimum level of IBA and NAA for rooting of chrysanthemum and to find an optimum interaction between rooting hormones i.e. IBA, NAA

and root fast levels and storage period at low temperature (4 C^{o}).

MATERIALS AND METHODS

The present study was carried out during the two successive seasons of 2013-2014 and 2014-2015. The experiment was conducted at a private farm in Talkha region and Baramoon Experimental Research Farm, Dakahlia Governorate, Egypt. The aim of this study was to determine the maximum period of tolerance of storage for chrysanthemum cuttings, optimum level of IBA, NAA and root fast for rooting of chrysanthemums cuttings and the optimal interaction between rooting auxins and storage period of low temperature (4° C±2).

Plant material:

Mother plants of Chrysanthemum *(Dendranthema grandiflora*, Tzevlev) var. "Looding" were obtained from a commercial nursery in El-Kanater El-Khaireia, El-Kalyobia region. All uniform non-rooted cuttings (3-4 pairs of leaves and a length of 8-10 cm) were monthly taken beginning from May to September and disinfected with Benlate (2 g/L).

The cuttings were stored in perforated bags of polyethylene as each package consists of 12 non-rooting cuttings and stored at (4° C±2) and RH (70-75 %) for different durations (0-time (control), 1, 2, 3 and 4 months).

After the end of storage period the basal leaves were removed and the bases were dipped in indolebutyric acid (IBA) at 500 and 1000 ppm; naphthalene acetic acid (NAA) at 500 and 1000 ppm and root fast (Table, A) at 5, 10 and 15 ppm for 10 min. After that, cuttings were planted directly as each cutting was planted in pots of 10 cm diameter filled by rooting media (peat moss, vermiculite and sand (2:1:1); kept under shade and irrigated by hand sprayer 6 times during the day until the beginning of rooting (15 days from planting) then transplanted to plastic pots of 25 cm diameter filled by peat moss and sand media 1:1 (v/v). During growth stage the plants were fertilized with 2 g / pot NPK 20:20:20 every 15 days and irrigated every three days. Table (B) and (C) pointed out the physical and chemical analyses of the experimental soil, according to Jackson (1973) and the Chemical analyses: of peat moss according to Shotyk, (1988).

Table A. Root fast composition:

Amino acids	3.5%	Triple carboxylic acids	1.0%
Vitamins	5.0%	Catalysts for the growth of roots	0.5%
Algae extract	10%	Boron	0.5%
Biosak	10%	Zinc	0.5%

Table B. Physical and chemical analyses of the experimental soil:

Physical analyses:					
Particle size distribution (%)			Texture	$CaCO_3$	O.M
Sand	Clay	Silt		%	%
26.75	22.09	58.12	Sandy Salt	1.3	1.59
Chemical analyses:					
pH	EC(ds/m)		Available (mg/kg)		
			N	P	K
7.7	2.25		38.98	41.75	334
Ion concentration (mmol/l)					
Mg^{++}	Ca^{++}	Na^{+}	Cl^{-}	HCO^{-3}	SO^{--4}
8.00	14.00	3.00	2.50	0.50	20.00

Table C. The Chemical analyses of peat moss:

K_2O (ppm)	P_2O_5 (ppm)	N (ppm)	pH	Salt content (g/L)
80 -190	70 -180	160 -70	5.7- 6.5	0.7- 0.9

The experimental design:

The layout of the experiment was factorial in completely randomized design: 40 treatment (5 treatments for the storage period × 8 treatments for rooting stimulants) x 3 replicate x 5 cuttings /replicate = 600 cuttings.

The following data were recorded:

- Data were taken after four weeks from planting for root parameters: Root length (cm), No. of roots, rooting % and root dry weight %.
- Data were taken after eight weeks from planting for the following parameters:

1. Vegetative growth parameters: plant height (cm), No. of leaves/plant, stem diameter (cm), height of offsets (cm), No. of offsets and vegetative growth dry weight (%).
2. Flowering parameters: No. of flowers/plant, flower diameter (cm), peduncle length (cm) and flower dry weight (%).
3. Total chlorophyll (mg/100g f.w.) was determined according to Yadova, (1986).

- Chemical analysis was determined in dry samples of leaves:

4. Total carbohydrates (mg/100 g d.w) were determined according to Sada and Manickam (1996).
5. Total nitrogen (%) was determined according to A.O.A.C (2005).
6. Reducing sugars was determined according to Sada and Manickam (1996).
7. Non-reducing sugars was determined according to Sada and Manickam (1996).

Statistical analysis:

All data were subjected to statistical analysis by using MSTAT-C. The results were subjected to analysis of variance (ANOVA) and the means were compared using L.S.D. at 5 % level of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

1- Main effect of different cold storage periods at low temperature on quality of chrysanthemum:

It is clear from Table (1) that, all treatments of cold storage periods significantly increased in the root parameters [root length (cm), No. of roots/cutting and root dry weight %] over storage for 4 months at $4C^0$, in the two seasons. The root parameters were gradually decreased by the extension of the cold storage period i.e., 2, 3 and 4 months at 4 C^o respectively in both seasons. Storage of non-rooting cuttings of chrysanthemum for one month significantly increased the root parameters as compared to control treatment in the two seasons.

Table 1. Number of roots/plant, root length, rooting % and root dry weight % of *Dendranthema grandiflora* as affected by cold storage period in the two seasons.

Cold storage period	No. of roots/plant		Root length (cm)		Rooting (%)		Root dry weight (%)	
	1st Season	2nd Season	1st Season	2nd Seaosn	1st Season	2nd Seaosn	1st Season	2nd Season
Control	27.99	30.74	7.83	11.46	66.08	66.98	29.801	28.562
One month	31.64	34.67	9.17	14.25	71.66	74.02	28.591	28.548
Two month	26.64	28.89	6.43	10.51	63.54	66.40	28.812	28.010
Three month	19.33	24.98	4.53	9.24	56.33	59.61	27.758	27.192
Four month	16.61	20.01	2.70	7.90	45.24	48.98	27.514	31.157
L.S.D at 0.05	0.53	0.21	0.21	0.23	0.59	0.39	29.801	28.562

This is an agreement with non-rooted chrysanthemum cuttings which stored for 5 - 6 weeks at -0.5 - 0°C according to Hardenburg *et al.* (1986). Moreover, Agulló-Antón *et al*. (2011) on *Dianthus caryophyllus*, mentioned that dark storage for up to 4 weeks at 5 °C increased the percentage of early rooted cuttings and the final number and length of adventitious roots. De Almeida and Agrárias (2002) on Chrysanthemum cvs. ("Super White", "Sheena", "Dark Orange Reagan" and "Town Talk") demonstrated that in winter, cold storage affected the rooting of cuttings, mainly after two weeks of storage for all cultivars. The rooting (%) was lower in the winter and the cuttings could be preserved for a shorter period while during the summer, cold storage could be up to 4 weeks without any problem. Also, Zenciriran (2010) on two standard carnation cvs. "Dianora" and "Vittorio, noted that the rooted cuttings showed differences in survival rates according to tested cultivar. Specifically, the cv. "Vittorio" had a better reaction to long-term storage. The survival and rooting rates of non-rooted cuttings after cold storage also showed differences depending on the cultivar tested. "Vittorio" reacted better to storage than the "Dianora" cultivar.

It is quite clear from the data presented in Table (2) that, the cold storage of non-rooting cuttings of chrysanthemum for one month at $4C^0$ significantly increased the vegetative growth parameters as compared to control treatment, in both seasons. On the other hand, treatments of storage period for 1, 2, 3 months and control significantly increased in the vegetative growth parameters [plant height (cm), No. of leave/plant, stem diameter (cm), height of offset] as compared to cold storage for 4 month treatments, respectively in the two seasons. The vegetative growth parameters were gradually decreased by the extension of the storage period i.e, 2, 3 and 4 months at 4 C^o in both seasons. This is an agreement with Lopez and Runkle (2008) on *Impatiens hawkeri*, they reported that increasing storage period from 0 to 5 d at 0 °C induced decrease in visual quality. Most characters were negatively affected after 16 d of propagation by storage at ≤5 and >25 °C.

Table 2. Plant height, No. of leaves/plant, stem diameter, No. of offset/Plant, offset height and vegetative growth dry weight (%) of *Dendranthema grandiflora* as affected by cold storage period, in the two seasons.

Cold storage period	Plant height (cm)		No. of leaves /plant		Stem diameter (cm)		No. of offsets/ plant		Offset height (cm)		Vegetative organs dry weight (%)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	35.26	39.28	31.35	34.30	1.351	1.455	16.93	19.48	6.16	7.18	30.166	32.923
One month	38.60	44.05	34.51	37.69	1.423	1.496	18.74	21.93	7.02	8.77	34.438	32.690
Two month	34.36	36.82	29.55	32.74	1.305	1.403	15.52	17.87	5.49	6.44	28.598	33.029
Three month	20.95	26.81	24.74	27.19	1.145	1.317	15.20	15.79	5.10	5.72	26.799	33.137
Four month	12.73	17.13	22.38	24.85	1.028	1.108	12.17	13.26	3.46	4.33	29.062	32.259
L.S.D at 5%	0.57	0.43	0.65	0.44	0.037	0.012	0.41	0.37	0.12	0.11	-	-

Data presented in Table (3) indicated that, there are significantly increments for flowering parameters : No. of flower/plant , flower diameter(cm) and peduncle length(cm)when the non-rooting of chrysanthemum were stored for 0-time ,1,2,3 months at $4C^0$ as compared to cold storage for 4 months treatment, in the two seasons. The Flowering parameters were gradually decreased by the extension of the storage period i.e 2, 3 and 4 months at 4 C^o in both seasons. Storage of non-rooting cuttings of chrysanthemum for one month significantly increased the flowering parameters as compared to control treatment in the two seasons .This is agreement with the findings of Rajapakse *et al*. (1996) on chrysanthemum [*Dendranthema ×grandiflora* Kitamura] cultivars. Flowers of plants grown from stored cuttings were smaller than those of non-stored cuttings. In stems, sucrose and glucose were reduced while fructose generally increased during low-temperature storage probably due to the breakdown of fructose. Results indicated that the chrysanthemum cultivars varies due to low-temperature storage potential, and the role of light is beneficial in maintaining quality of cultivars with short storage life at low temperatures.

Table 3. Number of flowers/plant, flower diameter, peduncle length and flower dry weight (%) of *Dendranthema grandiflora* as affected by cold storage period in the two seasons.

Cold storage period	No. of flowers/plant		Flower diameter (cm)		Peduncle length (cm)		Flower dry weight (%)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	5.85	7.01	6.66	6.88	12.18	14.90	40.293	33.394
One month	6.94	8.26	7.25	7.54	14.29	17.06	41.588	34.909
Two month	5.57	6.25	5.57	6.40	10.65	13.01	39.883	33.110
Three month	3.65	4.27	4.66	5.57	8.55	10.17	45.350	38.836
Four month	2.36	2.47	3.57	4.25	3.92	8.59	37.743	39.752
L.S.D at 5%	0.22	0.18	0.16	0.07	0.30	0.22	40.293	33.394

As for chlorophyll content in the leaves there gradual decreases with the increased storage periods from two up four months. Whereas, non-rooting cutting of chrysanthemum were stored for one month surpassed significantly in chlorophyll content control (0-time) and other different storage periods respectively (Fig. 1). Lopez and Runkle (2008) reported that chlorophyll content reduced as storage period increased from 0 to 5 days at 0 °C.

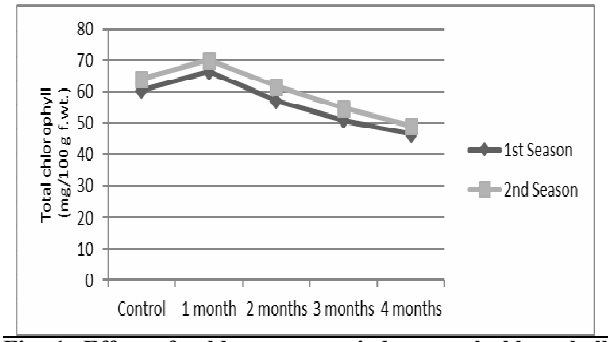

Fig. 1. Effect of cold storage period on total chlorophyll content in leaves of *Dendranthema grandiflora*, in the two seasons.

Concerning total nitrogen content as mg/100g d.wt. (Fig. 2) and total carbohydrates, reducing sugars and non- reducing sugars content as mg/100gd.wt.(Fig.,3) in the leaves of chrysanthemum under this study recorded the same trend mentioned above in Fig (1). The results coincided with those reported by Kubota *et al.* (1995): who studied low temperature storage potential of rooted garden chrysanthemum [*Dendranthema* x *grandiflorum* Kitamura] cultivar and its relationship with carbohydrate reserves. Results indicated that storage potential of rooted chrysanthemum cuttings varies considerably among cultivars and that the loss of carbohydrate pools is greater in cultivars with short storage life.

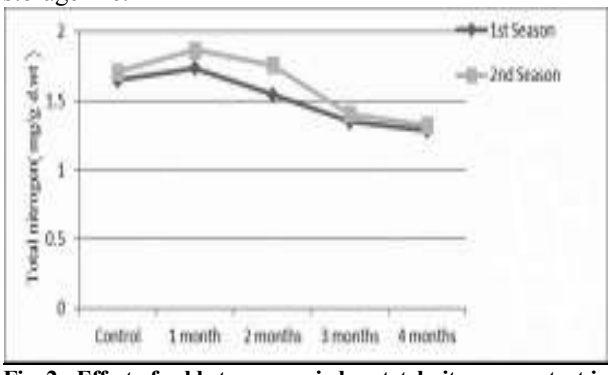

Fig. 2. Effect of cold storage period on total nitrogen content in leaves of *Dendranthema grandiflora*, in the two seasons.

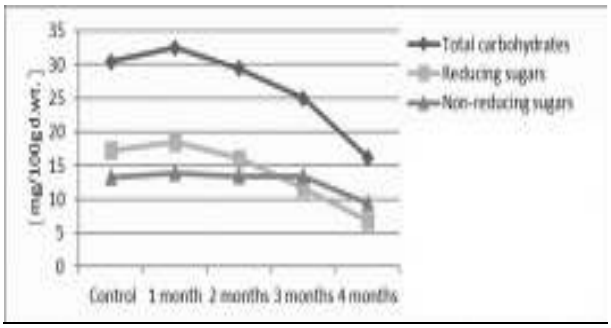

Fig. 3. Effect of cold storage period on total carbohydrates, reducing sugars and non- reducing sugars content in the leaves of *Dendranthema grandiflora*, in the two seasons.

2-Main effect of rooting stimulants treatments on the quality production of chrysanthemum:

The data shown in Table (4) indicated that pulsing non-rooting cuttings of chrysanthemum for 10 min. in all rooting stimulants concentrations (IBA, NAA and root fast) used in this study significantly increased number of roots/ cuttings roots, length and rooting % as compared to control treatment in both seasons. The highest concentration of IBA (1000 ppm) treatment surpassed significantly the root parameters when compared to other rooting treatments. These results supported by Sindhu *et al.* (2002) who reported that IBA at 250 ppm recorded highest number of roots per cuttings and longest root of chrysanthemum cv. "Flirt". In this regard, IBA treatments recorded highest percentage of rooting over NAA treatments at that concentration. Maximum percentage of rooting with IBA 400 ppm in chrysanthemum was observed by Grewal *et al.* (2005). However, Abbas and Ali (2014) observed on carnation (*Dianthus caryophyllus,* L.) that immersing cuttings in NAA with a concentration of 400 ppm significantly increased rooting percentage, number of roots/cutting. Also, Shi *et al.* (2013) mentioned that treating four cultivars of pot chrysanthemums with naphthylacetic acid (NAA) under cold storage enhanced the rooting parameters, since, root length and root fresh weight overall increased with 500-750 mg·L-1 NAA. Mehrabani *et al.* (2016) studied that auxin concentration and sampling time effect on rooting of *Chrysanthemum morifolium,* L and *Rosmarinus officinalis,* L. The results revealed that the highest rooting percentage (with three sampling times) and survival rate for Chrysanthemum (in August and September) was attained with 3000 mgl - 1 NAA. The greatest roots number in September and, root weight in August and September in Chrysanthemum again were belonged to 3000mgl-1

NAA. Auxin concentration had significant effect on root number, root fresh weight and survival rate of rosemary for both IBA and NAA, 3000 mgl-1.

The increasing in number of roots / cutting due to auxins are known to increase the cell division by increasing the level of endogenous cytokinins resulting in induction of more number of root primordial, exogenous application of auxins hastened the process of root initiation. Also the characteristic property of auxins was their action in stimulating the length of cells in their relevant growth stage. It appears likely that auxins initiate synthesis of structural enzyme proteins in the formation of adventitious roots thus increasing the root length through the process of acidification.

With increasing root fast concentration treatments, the root parameters were improved. Whereas, control treatment gave the lowest values to (17.64 and 19.99). There was a non constant trend with root dry weight (%).

Table 4. Number of roots, root length, rooting (%) and root dry weight (%) of *Dendranthema grandiflora* as affected by rooting stimulants treatments in the two seasons.

Rooting stimulants	No. of roots/cutting		Root length (cm)		Rooting (%)		Root dry weight (%)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	17.64	19.99	3.26	7.92	45.07	47.60	29.80	27.70
IBA at 500 ppm	27.36	30.69	7.39	11.95	67.83	70.52	27.94	28.10
IBA at1000 ppm	29.75	35.88	9.77	15.28	76.55	79.34	28.26	29.93
NAA at 500 ppm	25.61	28.05	5.96	10.50	60.64	63.54	28.29	28.14
NAA at1000 ppm	28.06	32.67	8.37	13.44	70.05	73.39	27.17	27.31
Root fast at 5 ppm	20.77	22.90	4.00	7.99	51.02	53.54	29.59	29.65
Root fast at 10 ppm	22.43	25.43	4.82	8.66	55.21	57.16	28.28	28.77
Root fast at 15 ppm	23.92	27.26	5.48	9.63	58.21	60.49	28.67	27.99
L.S.D at 5%	0.34	0.41	0.23	0.29	0.38	0.46	-	-

It is evident from data presented in Table (5) that the vegetative growth parameters (plant height, No. of leaves/plant, stem diameter, No. of offset/plant, offset height and vegetative growth dry weight % of *Dendranthema grandiflora*) as affected by rooting hormones treatments. The increment in these parameters was accompanied by most positive significant responses to dipping in IBA at 1000ppm for 10min. after storage periods and before planting as compared to other treatments, in the two seasons. In this concern, Shahab (2013) suggested the assessment of IBA levels and planting time for rooting and growth of Alstonia cuttings. IBA at 10 % gave best results among leaf area, sprout length, stem diameter, while No. of leaves, and survival % were best recorded when treated with IBA at level of 5 %. IBA at 10 % level and 14th April as planting time resulted in overall best performance and is recommended for Alstonia cuttings. Yeshiwas *et al*. (2015) on rose cuttings treated with 1000 ppm of IBA had shown significant positive effects on shoot fresh and dry weights, leaf number and shoot length.

Table 5. Plant height, No. of leaves/plant, stem diameter, No. of offset/plant, offset height and vegetative growth dry weight (%) of *Dendranthema grandiflora* as affected by rooting stimulants treatments in the two seasons.

Rooting stimulants	Plant height (cm)		No. of leaves/plant		Stem diameter (cm)		No. of offset/ Plant		Offset height (cm)		Vegetative growth organs dry weight (%)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	19.15	22.00	19.92	19.15	22.00	19.92	9.74	10.85	3.03	3.50	25.15	32.42
IBA at500 ppm	33.20	37.80	33.01	33.20	37.80	33.01	18.67	20.19	6.61	7.74	34.15	31.87
IBA at1000 ppm	36.42	45.95	36.33	36.42	45.95	36.33	21.27	24.97	7.49	9.74	32.91	33.76
NAA at 50 ppm	29.94	32.75	29.52	29.94	32.75	29.52	16.94	18.63	6.00	6.70	30.97	32.73
NAA at1000 ppm	34.24	40.54	34.17	34.24	40.54	34.17	19.60	21.69	7.02	8.45	33.71	33.15
Root fast at 5 ppm	21.97	25.30	22.57	21.97	25.30	22.57	11.36	12.75	3.65	4.33	26.13	32.28
Root fast at10ppm	24.62	27.70	25.15	24.62	27.70	25.15	13.27	15.31	4.51	5.34	28.21	32.97
Root fast at15ppm	27.50	30.49	27.39	27.50	30.49	27.39	14.84	16.95	5.27	6.10	30.05	33.48
L.S.D at 5%	0.41	0.53	0.51	0.41	0.53	0.51	0.33	0.35	0.18	0.19	-	-

The main effect of dipping non rooted cutting in different rooting stimulants concentrations (IBA, NAA and root fast) before planting on flowering parameters of chrysanthemum in Table (6) showed that each of number of flowers/plant, flower diameter, peduncle length and flower dry weight% of *Dendranthema grandiflora* followed the same trend as mentioned before in vegetative growth parameters (Table, 5).

Table 6. Number of flowers/plant, flower diameter, peduncle length and flower dry weight (%) of *Dendranthema grandiflora* as affected by rooting stimulants treatments in the two seasons.

Rooting stimulants	No. of flowers/plant		Flower diameter(cm)		Peduncle length(cm)		Flower dry weight (%)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Control	2.50	3.02	3.35	4.02	6.19	7.82	39.01	35.39
IBA at500 ppm	5.87	6.83	6.78	7.14	12.05	14.20	42.34	36.24
IBA at1000 pm	7.21	8.84	7.62	8.17	13.15	20.12	43.71	37.80
NAA at 500 ppm	5.04	5.63	5.75	6.35	10.55	12.37	41.87	36.24
NAA at1000 ppm	6.55	7.73	7.19	7.58	12.45	15.80	43.16	37.23
Root fast at 5 ppm	3.53	3.45	3.79	4.48	7.04	8.87	37.33	31.78
Root fast at 10ppm	3.86	4.43	4.50	5.15	8.31	10.45	38.88	32.73
Root fast at 15ppm	4.45	5.27	5.34	6.11	9.61	12.34	41.05	36.41
L.S.D at 5%	0.16	0.17	0.15	0.08	0.25	0.26	-	-

Regarding the dipping treatments of chrysanthemum non-rooting cuttings in different rooting stimulants concentration (IBA, NAA and root fast), it is clear from Fig. (4) that most of rooting stimulants under this study increased the total chlorophyll as compared to control. Generally, increasing rooting auxin concentrations enhanced the total chlorophyll content. The highest total chlorophyll content was recorded by dipping non-rooting cutting of chrysanthemum in IBA at 1000ppm for 10min. before planting as compared to other treatments.

As shown in Fig (5), the similar trend was observed with total nitrogen content and total chlorophyll content in the leaves.

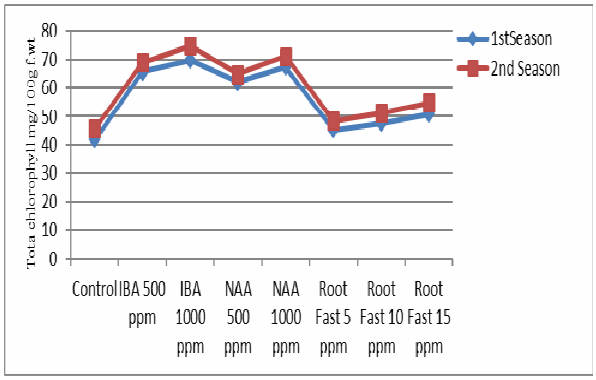

Fig. 4. Effect of rooting stimulants treatments on total chlorophyll content in the leaves of *Dendranthema grandiflora*, in the two seasons.

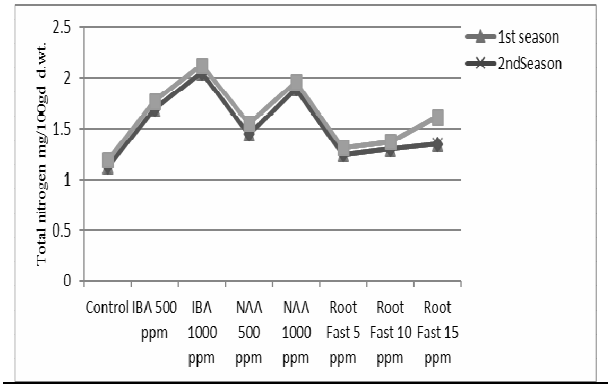

Fig. 5. Effect of rooting stimulants treatments on total nitrogen content in the leaves of *Dendranthema grandiflora*, in the two seasons.

The results illustrated in Fig. (6) revealed that dipping non-rooted cuttings of chrysanthemum in IBA at 1000 ppm for 10 min. before planting was more effective on total carbohydrates and reducing sugars contents than other treatments. Concerning non–reducing sugars, there was non constant trend could be observed between all treatments in this study. These results are in line those reported by Husen and Pal (2007) on *Tectona grandis,* Linn. cuttings, they found that exogenous application of auxins, i.e. NAA and IBA had significant positive effect on the percentage of rooting. The maximum percent rooting was obtained with 4,000 ppm IBA as compared to other treatments. The overall rooting response was better in the treatment with IBA rather than with NAA. Application of NAA and IBA to shoot cuttings resulted in an increase in the level of total soluble sugars, starch, protein, and PER-activity in the rooting zone.

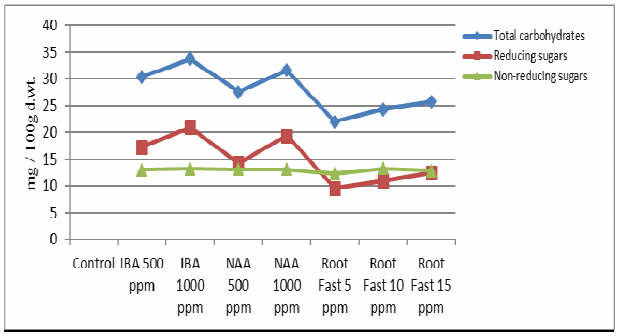

Fig. 6.Effect of rooting stimulants treatments on total carbohydrates, reducing sugars and non-reducing sugars in the leaves of *Dendranthema grandiflora*, in 2nd season.

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دراسات فسيولوجية على التخزين البارد للعقل قبل التجذير وبعض منشطات التجذير على جودة الأراولا

أ ـ تأثير فترات التخزين البارد للعقل قبل التجذير وبعض منشطات التجذير

على فتحى حمايل [١] ،ماجدة مصطفى السقا [٢] ، السيد عطيه حامد البرعى [١] و محمد محمود عبدالعاطى [٢]

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أجريت هذه التجربة خلال موسمي ٢٠١٤/٢٠١٣ و ٢٠١٥/٢٠١٤ لتحديد أنسب فترة لتخزين عقل الأراولا على درجة حرارة ٤ °م بدون أي تأثير على قياسات النسبة المئوية للتجذير وجودة الجذور المتكونة والنمو الخضري والإزهار. وأيضاً لتحديد أنسب تركيز من أندول حمض البيوتريك ، نفتالين حمض الخليك و الروت فاست (مخصب حيوى) للأراولا. أظهرت النتائج أن جميع معاملات التخزين في الفترة من (شهر : ثلاث شهور) أدت إلى زيادة معنوية في القياسات الجذرية ، النمو الخضري ، الإزهار ، الكلوروفيل الكلى ، النتروجين الكلى والكربوهيدرات الكلية مقارنة بالتخزين البارد لمدة ٤ شهور على درجة حرارة ٤ °م فى كلا الموسمين. أظهرت جميع الصفات السابقة إنخفاض تدريجى نتيجة إطالة مدة التخزين على سبيل المثال ٢ و ٣ و ٤ شهور على درجة حرارة ٤ °م في كلا الموسمين. أدى تخزين عقل الأراولا قبل التجذير لمدة شهر إلى زيادة معنوية في معظم القياسات مقارنة بمعاملة الكنترول في كلا الموسمين. أدى نقع عقل الأراولا قبل التجذير لمدة ١٠ دقائق في جميع تركيزات الأوكسينات (أندول حمض البيوتريك ، نفتالين حمض الخليك و الروت فاست (مخصب حيوى) المستخدمة في هذه الدراسة إلى زيادة معنوية في جميع القياسات مقارنة بمعاملة الكنترول في كلا الموسمين. أظهر إستخدام أندول حمض البيوتريك إلى تركيز (١٠٠٠ جزء في المليون) تفوق معنوي على باقي تركيزات أوكسينات التجذير. كما أدت زيادة تركيز الروت فاست إلى تحسين جميع القياسات تحت الدراسة.