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USE OF SOILLESS CULTURE TECHNIQUE IN THE PRODUCTION OF CHRYSANTHEMUM (*Denderanthema grandiflora Ramat)* CV."ZEMBLA"

[38]

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ABSTRACT

This research study was carried out during the two successive seasons of 2017/2018 and 2018/2019 at the farm located within the vicinity of the Arid lands Agriculture graduated studies and Research Institute (ALARI), Shobra Elkheima, Qalyobia governorate, Egypt, under an unheated plastic-house (25 m length x 9 m width x 3.5 m height). The experiments were laid out in a completely randomized design (CRD) with 3 replications, and the result data were subjected to analysis of variance (ANOVA). Chrysanthemum (*Denderanthema grandiflora* Ramat) cv. Zembla was employed in this research imported initially from DELIFLOR Company, in the Netherlands. Seedlings were planted in different substrate cultures to determine the most suitable local mixes for their cultivation and maximum production. Three of them were chosen from the local environment namely Water hyacinth, Palm fiber and Sugar-cane refuse in addition to Sawdust and Peat moss. The seedlings were planted into pots filled with eleven substrate culture mixes as follow: Water hyacinth (WH), WH + peat moss (1:1), Palm fibers (PF), PF + Peat moss (1:1), Coarse sawdust (CS), CS + Peat moss (1:1), Fine sawdust (FS), FS + peat moss (1:1), Sugar-Cane refuse (SC), SC + Peat moss (1:1) and Peat moss. The results indicated that the substrate combination of PF + peat moss (1:1) and WH + peat moss (1:1) gave higher significant values when compared to other remaining substrate with regards to vegetative parameters, i.e. plant height, stem diameter, number of leaves per plant and greenness of leaves as SPAD reading values. Also flower diameter exhibited a higher significant increase when PF + peat moss (1:1) + WH+ peat moss substrate combination was used compared to the other remaining substrates. Flower vase life also was influenced by the local substrate used in bringing up the cut-flowers and showed longer standing in the preservative solution when flowers were obtained from both of WH + peat moss (1:1) and Palm fiber + peat moss (1:1) compared to other substrate culture mixtures.

Keywords: Chrysanthemum, Substrate culture, Cut- flowers, Soilless culture, Water hyacinth, Palm fibers, Sawdust, Peat moss, Sugar-cane refuse.

INTRODUCTION

Flowers add a pleasure through illuminating colors and spreading fragrance **(Manzoor et al 2001)**. Ornamental plants mostly exist in two forms, viz. pot plants and cut- flowers. Cut-flowers have a huge market worldwide. One of the important cut-flowers is chrysanthemum. Chrysanthemum belongs to the family *Asteraceae*. Chrysanthemum is very popular throughout the world. The shape of crown, beautiful colors and reasonable price make it dominant in most of the flower industries. Chrysanthemum production in soilless culture systems has been studied and developed for more than 30 years. In greenhouse production chrysanthemum is brought up through soilless cultivation by hydroponic culture besides soilless media coco-peat, perlite, etc**. (Handreck and Black, 1994).** Production of chrysanthe-

mum requires an optimum mixture of macro, micronutrients compared with the use of soil several soilless systems and nutrient film techniques can lead to higher productivity **(De Visser and Hendrix, 1987).**

Soilless cultivation is becoming increasingly important as it is easier to control both the chemical and physical properties of the growth environment and substrate/medium can be selected having negligible chemical activity **(Barbosa et al 2000).**

(Verhagen, 1993) found chrysanthemum can be cultivated all year around in Coarse- grade peat as a substrate. Most chrysanthemum producers grow it in soilless mixes, which include peat, pearlite and vermiculite **(Wang and pokorny, 1989).** Simiralry, **(Dutt and Sonawane, 2006)** observed excellent performance of chrysanthemum (*Chrysanthemum indicum L*.) on a substrate containing cocoa-peat, compost, rice husk.

(Wright et al 2008) found that pine tree substrate for chrysanthemum production in greenhouse can be used as peat-lite medium.

The development of alternatives for peat substrates is necessary for the following reasons: (i) the resources of peat are limited, (ii) the pressure for using waste coming from human or industrial activities increases rapidly, and (iii) the economic necessity to use locally produced waste products is pressing **(Szajdak et al 2016).**

(Pizano, 2002) stated that in tropical and subtropical countries the increase of flower production in substrate culture had been slowed down because the high investment. New substrate components may offer better conditions for plant growth at the same time reduce production costs when compared with peat moss.

Therefore it was thought like a good idea to conduct experiments to find out the most available and suitable local mixture substrates in Egypt which would be more attractive and feasible for the production of cut-flower chrysanthemum.

MATERIAL AND METHODS

Location and duration

The experiments of this research study were conducted in the experimental location of the Aird lands Agriculture Research Institute (ALARI), Shobra EL Kheima, Qalyubiyya, Egypt in two successive seasons 2019 and 2020.

Substrate culture types and treatments

Six different types of substrates were chosen for this research study (water hyacinth, palm fibers, coarse sawdust, fine sawdust, peat moss, and sugar-cane refuse). All in all, eleven treatments were made up from the six substrates either separately or in combinations, as follow:

Treatment	Formulation
T1	Water hyacinth (WH)
T2	Water hyacinth : peat moss 1:1
T3	Palm fiber (PF)
T4	Palm fibers: peat moss 1:1
T5	Coarse sawdust (CS)
T6	Coarse sawdust : peat moss 1:1
T7	Fine sawdust (FS)
T8	Fine sawdust : peat moss 1:1
T9	Sugar-cane refuse (SR)
T10	Sugar-cane refuse : peat moss 1:1
T11	Peat moss (PM)

Plant material and growing conditions

Seedlings of chrysanthemum (*Dendranthema grandiflora.Ramat*) cv. Zembla were used in this research study. It was imported initially from DELIFLOR Company, Netherlands. The variety is strong with excellent quality stems. The flower color is white. The seedlings length was about 10 cm and contains 6-7 pairs of leaves. They were bought from Flora Mix Company. In the beginning of August, the

chrysanthemum seedlings were initially cultivated in pots (No.12cm) filled with perlite: peat moss mix (1:2 v/v) to help them form new roots. After three weeks the seedlings were transplanted in substrate culture in pots (No.25cm) after getting rid of the initial media by washing and put under a plastic-house. A pinching treatment was applied after two weeks from the transplanted to encourage side branching. Pots were spaced out at a distance of 30 cm between each other. Each plant was irrigated by a drip emitter 2 L/hour with nutrient solution three times a week for all substrate treatments except sawdust ones it was only two times a week. Long- day condition from incandescent lamps (100 W) was provided for plants between 6.00 pm to 12.00 am for eight weeks.

Data Collected

Morphological characteristics

- **Plant height** (cm) using a graduated ruler**.**
- **Leaf number/ plant.**
- **Stem and flower diameter** (cm) using a digital caliber.
- **Flower vase life.** Number of days from putting the flowers in a preservative solution until leaves turned to yellow color.
- **Leaf greenness** was estimated using a SPAD**.**

Experimental Design and Statistical Analysis

The experiment of each season was arranged in a completely randomized design with three replications for each treatment. Result data were subjected to analysis of variance (ANOVA). Data were statistically analyzed according to the separation among means using Duncan multiple range test (**Duncan, 1955**).

RESULTS

Influence of Substrate-culture Treatments on Vegetative Parameters

Data presented in **Table (1)** show the effect of that, plant height, stem diameter, number of leaves exhibited significant increases when plants were cultured in T2 and T4 substrates when compared to other substrates. Both substrate mixtures T2 and T4 gave the tallest plants in 1st season (55.25 and 56.25 cm) and exactly the same in the 2nd season (55.25 and 56.25 cm), respectively. Whereas, the shortest plants were obtained when plants were cultured in the T7 substrate (13.05 and 13.18 cm, in respect order by season). As for stem diameter, T4 showed the largest stem diameter (5.47 and 4.60 mm, in respect order by season) compared to other substrates. Meanwhile, the lowest stem diameter was obtained from T5 (3.32 and 3.20 mm, in respect order by season). Leaf number/plant showed significant increase when plants were cultured on T2 and T4 in 1st season (50.12 and 48.87) and exactly the same in the 2nd season (50.12 and 48.87), respectively. Whereas, the lowest number of leaf/plant were obtained when plants were cultured in T7 substrate (13.00 and 13.0 cm, in respect order by season).

Influence of Substrate-culture Treatments on leaf chlorophyll (SPAD) and flower characters

Data illustrated in **Table (2)** show the effect of different substrates on leaf chlorophyll color, flower diameter and vase life. Leaf chlorophyll color was increased when plants were cultured in T4 in the 1st season (70.43) and in the 2nd season (70.83 and 74.16), respectively. Whereas, the lowest leaf chlorophyll color values were obtained when plants were cultured in the T7 substrate (44.95 and 40.31) in respect order by season.

Flower diameter revealed significant increases when plants were cultured in T2 and T4 in the 1st season (14.81 and 15.12 cm) and in the 2nd season (15.00 and 14.75 cm), respectively. Whereas, the lowest number of leaves were obtained when plants were cultured in the T7 in the 1st season and T8 in the 2nd season (10.75 and 12.62 cm) respectively.

As for vase life, cut-flowers resulted from substrate culture treatments exhibited a longer postharvest life period when obtained from T2 and T4 in the 1st season (14.05 and 14.05 days) and in the 2nd season (14.62 and 14.05 days), respectively. Whereas, the lowest vase life values were obtained when flower came from T5 (9.37 and 9.62) in respect order by season.

Table 1. Effect of substrate-culture treatments on plant height, stem diameter and number of leaves of chrysanthemum *(Denderanthema grandiflora Ramat).cv* "Zembla"

Substrate	Plant height (cm)		Stem diameter (mm)		Number of leaves/plant	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
T1	47.75b	47.75b	4.35b	3.62e	43.87b	43.87b
T2	55.25a	55.25a	4.43b	4.27b	50.12a	50.12a
T3	47.87b	47.87b	4.39b	4.19b	44.07b	44.75b
T4	56.25a	56.25a	5.47a	4.60a	48.87a	48.87a
T5	14.00fg	13.37d	3.32c	3.20h	14.87f	14.87f
T6	15.87ef	15.31d	3.46c	3.38g	23.62d	23.62d
T7	13.05g	13.18d	3.36c	3.35g	13.00f	13.00 f
T8	17.12e	15.31d	3.56c	3.52ef	18.12e	18.12e
T9	33.87d	14.37d	3.50c	3.44fg	22.12d	22.12d
T10	47.37b	31.05c	4.47b	4.01c	27.62c	27.62c
T11	39.12c	46.93b	3.45c	3.85d	44.56b	45.87b

Means followed by the same letter in the column do not differ at the 5% probability by the duncan test. T1: Water hyacinth, T2: Water hyacinth + peat moss, T3: Palm fibers, T4: Palm fibers + peat moss, T5: Coarse sawdust, T6: Coarse sawdust + peat moss, T7: Fine sawdust, T8: Fine sawdust + peat moss, T9: Sugar-cane refuse, T10 Sugar-cane Refuse + peat moss, T11: Peat moss.

Table 2. Effect of substrate-culture treatments on leaf chlorophyll (SPAD), flower diameter and Vase life of chrysanthemum (*Denderanthema grandiflora Ramat)* cv."Zembla"

Substrate	Chlorophyll (SPAD)		Flower diameter (cm)		Vase life (days)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
T1	54.45 de	56.23cd	14.31bc	14.5abc	13.00c	13.00c
T2	64.66 ab	70.83 a	14.81ab	15.00a	14.05a	14.62a
T3	58.26 bcd	59.00 bc	13.90c	14.06cd	13.00c	13.00c
T4	70.43 a	74.16a	15.12a	14.75ab	14.05a	14.05a
T5	45.03f	45.16f	12.56e	12.81fg	9.37g	9.62g
T6	55.88cde	48.73ef	13.68cd	13.37ef	11.00e	11.05e
T7	44.95 f	40.31 g	10.75g	10.05h	8.05h	8.37h
T8	53.15 de	45.53 f	12.87e	12.62g	10.00f	10.00g
T9	48.86 ef	49.04 e	13.68cd	11.06h	13.37b	10.05f
T10	54.35 de	55.01 d	11.81f	13.62de	10.25f	12.25d
T11	62.56 bc	61.46 b	13.18de	14.25bc	12.00d	13.62b

Means followed by the same letter in the column do not differ at the 5% probability by the duncan test. T1: Water hyacinth, T2: Water hyacinth + peat moss, T3: Palm fibers, T4: Palm fibers + peat moss, T5: Coarse sawdust, T6: Coarse sawdust + peat moss, T7: Fine sawdust, T8: Fine sawdust + peat moss, T9: Sugar-cane refuse, T10 Sugar-cane Refuse + peat moss, T11: Peat moss.

DISCUSSION

A growing medium should maintain a plant and supply it with water, nutrients, and the right conditions for exchanging gas in the root zone. The root system requires a sufficient amount of oxygen and free space between the substrate solid particles. Choosing a substrate is one of the decisive factors influencing cultivation of ornamental plants.

The principal constituent of a horticultural substrate is peat. Depending on its origin and the depth of a bed, the peat exhibits different physicochemical and biological properties **(Szajdak et al 2016).** Substrate with acceptable physical and chemical properties or suitable characteristics for a specific soilless substrate culture system could be prepared by mixing adequate proportions of the different particle size **(Noguera et al 2003).**

The choice of a medium component used depends on the availability of materials, cultivation methods, and the size and type of a container used for rooting **(Szajdak et al 2016).** The need to reduce the amount of imported materials for potting mixture is becoming essential. The most significant alternative found in some countries was coir dust resulted from coconuts by-products **(Reddy, 2019). Stamps and Evans (1997)** concluded that coir dust was an adequate substitute for sphagnum peat and could be used for growing *D. maculate*.

In this research study, PF + peat moss substrate followed by WH + peat moss substrate significant proved to be successful partial substitutes for pure peat moss, via simply substituting peat moss by 50% of above local materials, The physiochemical properties in palm and water hyacinth media were better than others in increasing growing indexes. The low amount of bulk density and high amount of porosity allowed plant roots to penetrate in the substrate more easily.

Contrariwise, both fine and coarse sawdust substrate gave the lowest value with all characteristics due to the high C:N ratio and the high amount of bulk density, low amount of porosity.

From result data obtained herewith, it was clear that both substrate treatments, i.e. water hyacinth + peat moss and palm fibers + peat moss were superior in giving maximum positive results in all vegetative parameters measured (plant height, flower diameter, number of leaves/plant and chlorophyll SPAD readings) in addition to extended vas life of cut-flowers of chrysanthemum cv."Zembla".

Most likely both local substrates, viz. water hyacinth and palm fibers when added to peat moss improved the overall physical structure of both substrate cultures, Accordingly, air spaces between particles of both substrates were larger around the root zone of chrysanthemum which struck the right balance for aeration and water holding capacity around the root zone of chrysanthemum cv."Zembla".

Besides, when peat moss was added to both water hyacinth and palm fibers substrates the pH of both substrates was lowered sufficiently in a favorable manner (refer to appendix 1). Definitely, this led to make nutrient elements around the root zone available for absorption by roots **(Alam et al 1999).** This was ultimately reflected on the wellbeing and healthy conditions of the final cut-flowers obtained from chrysanthemum cv. "Zembla".

In contrast, sawdust (both coarse and fine) as a substrate was inferior in all aspects of result data of chrysanthemum cv. "Zembla". Despite the fact that irrigation water was added less frequent (two times weekly instead of three times for the rest of substrate culture treatments, still the water holding capacity of water was apparently high around the root zone with noticeable poor drainage of excess water. Undoubtedly, the roots of chrysanthemum cv. "Zembla" must have suffered greatly from less air in substrate cultures involving sawdust which led to less absorption of nutrient elements and in final poor performance.

Luckily enough, the two selected local substrates, namely water hyacinth and palm fiber, which gave advantageous and favorable results with chrysanthemum cv. "Zembla" are available in abundance in the Egyptian environment and in prices too. Using them to partially substitute peat moss would not only make us less dependent on an imported expensive commodity but also would reduce the final cost of substrate mixes used as culture media in the production of a lot of horticultural crops raised by soilless culture.

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Appendix (1)

Chemical analysis of a sample of the experimental substrate-culture mixes used in the production of chrysanthemum cv. "Zembla"

Sample	PH at 1:10	EC (dS/m) at 1:10	%			
			O.C	N	P	K
Water hyacinth	8.24	0.73	19.20	1.25	0.26	0.47
Water hyacinth + peat moss	4.90	2.34	20.20	0.79	0.20	0.66
Palm fiber	7.09	6.38	20.60	1.01	0.25	0.89
Palm fiber + peat moss	5.58	0.73	20.60	0.48	0.05	0.05
Coarse sawdust	6.64	1.08	20.20	0.11	0.02	0.07
Coarse sawdust + peat moss	4.35	0.73	21.00	0.30	0.04	0.04
Fine sawdust	6.55	1.42	20.40	0.19	0.03	0.08
Fine sawdust+ peat moss	4.67	0.74	20.80	1.01	0.25	0.89
Sugar-cane refuse	7.16	2.30	21.00	0.95	0.40	0.34
Sugar-cane refuse+ peat moss	5.97	1.87	20.80	0.87	0.15	0.14
Peat moss	4.20	3.37	20.80	0.95	0.40	0.34

Analysis was carried out by the lab of (ALARI), Ain Shams University

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إستخدام تقنية الزراعة بدون تربة فى إنتاج نبات الأراولا (*Denderanthem grandiflora Ramat)* cv. "Zembla"

[38]

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1– معهد الدراسات العليا والبحوث الزراعية بالمناطق القاحلة – جامعة عين شمس – شبرا الخيمة – القاهرة – مصر

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الموجـــــــــز

أجريت هذة الدراسة خلال عامين 2017/2018 و2018/2019 فى المزرعة الواقعه فى معهد الدراسات العليا والبحوث الزراعية بالمناطق القاحلة، شبرا الخيمة، محافظه القليوبية، مصر، تحت صوبة بلاستيكية (الطول 25م× العرض 9 م × الأرتفاع 3.5م) . صممت التجربة تصميم تام العشوائية فى ثلاث مكررات. تم زراعة الشتلات فى عدة بيئات مختلفة لتحديد أنسب بيئة محلية من أجل الزراعة والإنتاج. وقد تم اختيار ثلاث بيئات محلية وهم ورد النيل– ألياف النخيل– قصب السكر بالأضافة الى نشارة الخشب– البيتموس. وقد زرعت الشتلات داخل أصص (25سم) فى أحد عشره بيئة وهما كالأتى :ورد النيل – ورد النيل +بيتموس(1:1)– ألياف نخيل– ألياف النخيل +بيتموس(1:1)– نشارة خشب خشنة + نشارة خشب خشنة + بيتموس(1:1)– نشارة خشب ناعمة– نشارة خشب ناعمة +بيتموس(1:1)– قصب السكر– قصب السكر + بيتموس(1:1) + بيتموس. أوضحت النتائج أن بيئة ألياف النخيل + بيتموس (1:1) وبيئة ورد النيل + بيتموس (1:1) قد أعطت أفضل النتائج بالمقارنة مع البيئات الأخرى فى القياسات الخضرية (طول النبات– قطر الساق الرئيسى– عدد الاوراق/ للنبات– قياس درجة الأخضرار) وأيضاً فى القياسات الزهرية (قطر الزهرة) أدت بيئة ألياف النخيل+ بيتموس (1:1) و بيئة ورد النيل + بيتموس (1:1) الى زيادة ملحوظة بالمقارنة بالبيئات الأخرى. وقد تأثر أيضاً قياس عمر الزهرة بالبيئات المحلية المستخدمة فى تربية زهور القطف ولوحظ فترة بقاء أطول للأزهار الناتجة من كلاً من بيئة ورد النيل + بيتموس و بيئة ألياف النخيل + بيتموس داخل محلول الحفظ بالمقارنة بالبيئات الأخرى.

الكلمات المفتاحية: الأراولا، البيئات البديلة، زهور القطف، الزراعة بدون تربة، ورد النيل، ألياف نخيل، نشارة خشب، بيتموس، مخلفات قصب السكر

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