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RESPONSE OF CINERARIA PLANT TO WATER STRESS AND COMPOST SOURCES UNDER DRIP IRRIGATION SYSTEM

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ABSTRACT

Cineraria *(Senecio cruentus)* are admired flowering potted plants due to their wide range of colors. It is considered as very sensitive to water stresses. Pot experiments under open field condition, were conducted during the two growing seasons 2004/2005 and 2005/2006 at the Experimental Station of Ornamental Plants, Fac. of Agric., Mansoura Univ., to investigate the effect of different irrigation water regimes and composts application as soil conditioners, prepared from rice straw, cotton and maize stalks, as well as their interactions on growth, flowering and chemical composition of cineraria plants. Crop-water requirements were based on Class-A pan evaporation , however, four irrigation treatments were tried: Ep 0.6, Ep 0.8, Ep 1.0 and Ep 1.2, which were equivalent to the applications of 60%, 80%, 100% and 120%, respectively, of the evaporated depth of water from Class-A pan.

Results indicated that although all the amount of irrigation water treatments improved the growth and chemical composition (Chlorophyll a and b mg/g f.w., nitrogen percentage and its uptake), irrigation application equal to 120% of Class A pan evaporation depth proved to be the most favorable as the maximum content of chlorophyll and nitrogen uptake were improved. Regarding soil conditioners, several characters were improved due to composts addition such as plant height, leaf area, both number of branches and flowers per plant as well as diameter of display (cm). In addition, results also, showed that the contents of chlorophyll a and b and nitrogen in leaves were significantly increased as a result of composts application. On the other hand, porosity and saturation percent values increased with the addition of soil conditioners, but bulk density take the opposite. For the best vegetative growth and flowering of cineraria plants, it may be recommended to be irrigated equal to 120% of Class A pan evaporation depth using maize compost as soil conditioner with a rate of 0.2 kg/pot.

INTRODUCTION

Cineraria (*Senecio cruentus,* Family *Asteraceae*) is one of the largest genera of flowering plants. It is a very showy flowering pot plant and has many daisy like flowers available in wide range of colours and patterns (Bailey and Zoe, 1976). Cineraria as a valuable winter flowering pot plant grows in cool climates producing large massed heads of white, pink, red, purple, deep and light blue daisy like flowers. Moreover, there are some cultivars which have rings of other shades embedded in the blooms.

Water is fast becoming an economically scarce resources allover the world, especially in arid and semi-arid regions, as in Egypt. However, water is a limiting factor for any agriculture development processes. On the other hand, more efforts towards developing management practices, efficient use of water and developing the irrigation methods, especially for ornamental crops, are very important. Drip irrigation method has been considered the most obligatory irrigation method, that represents higher application efficiency, lower labor costs and saving energy and unit water.

Accurate determination of crop-water requirements (especially for ornamental crops, that represents highly economical returns), when and how much water should be applied to get the most out-put of each water unit. Therefore, a Class-A evaporation pan, is considered as one of the accurate method for estimating the crop-water consumptive use.

One problem of especial note is the fact that a pan services as a water source particularly in semi-arid areas. Thus, in areas where irrigation is often practiced, an evaporation pan may be one of the few water sources for wildlife. Thus, care must be taken into obtaining accurate data from a pan by the sitting of the pan and monitoring of ancillary meteorological data.

One of the most important parameters for estimating evapo-transpiration using Class-A pan is that the *kp* value which represents an adjustment factor to relate free water loss to crop-water loss.

Stanhill (2002) stated that the US Class A evaporation pan should be broadly used for irrigation scheduling due to its low cost and ease of measurement and maintenance. Many studies on the irrigation of agricultural crops have been accomplished using the US Weather Service Class A pan evaporation (Shalhevet *et al.*, 1983 and Waddell *et al.*, 1999). Nevertheless, it is not commonly used for scheduling irrigation of decorative plants such as the Cineraria. Several workers came to similar conclusion such as Papadopoulou *et al.* (1996) on gerbera and Abdel-Kafie (2002) on cineraria plants.

Soil conditioning means improving the soil physical conditions, particularly, for better aeration, water and heat which are limiting factors for agricultural production. Traditional methods are the application of organic matter, composts, plant residues, peat and clay especially to improve soil physical properties. Many investigators including Mohamed and Matter (2001) and Badran (2002) reported that compost with its content of humic substances and microbial materials, has been shown to improve soil physical, chemical and microbiological conditions, moisture content, and reduce leaching of nutrients, water run-off and soil erosion. Moreover, Ali *et al.* (2001) stated that the organic matter could improve the soil water holding capacity, caution exchange capacity, nutrient retention and soil microbial activity. Raviv (2005) stated that compost is an organic matter that has undergone partial thermophilic, aerobic decomposition.

This environmentally safe process is called composting. Three kinds of composts were used: rice, maize and cotton residues. Burning the trashes of these crops has harmful environmental implications through global addition of carbon dioxide and high health costs due to increase respiratory problems in the local population (Samara *et al.*, 1999). Uses are needed for residues of such field crops in order to dispose them in an environmentally friendly way since they could be converted into value added compost which may have the potential to improve productivity of crops as well as reduce environmental pollution. Similar findings were obtained by Zaghloul and Moghazy (2001) on gladiolus and Zarad and Mohamed (2005) on *Stevia rebaudiana* plants.

One the other hand, nitrogen has often been recognized as a limiting factor for microbial growth and activity during the decomposition of plant residues (Recous *et al.*, 1995), especially in material with a high C/N ratio such as wheat straw. However, experiments on the effect of additional N supply on the decomposition of plant residues showed different results, ranging from positive to negative effects on the decomposition rate (Fog, 1988). Since, the effect of added N on decomposition process may depends on the plant material as degradation is influenced by nutrient content and anatomical structure of the material.

The specific objectives of this research were to:

(1) study the possibility of using the US Weather Service Class-A pan for water management of multi port drip irrigated cineraria in an arid climate,
(2) determinate the optimum plant-pan coefficient value for cineraria plant,
(3) evaluate the comparative effectiveness of three sources of composts on growth, flowering and chemical composition of cineraria plant and
(4) studying the influence of different types of composts on soil physical properties.

MATERIALS AND METHODS

The present investigation was performed at the Experimental Station of Ornamental Plants, Faculty of Agriculture, Mansoura University (latitude 31.05°-N, longitude 31.25°-E and altitude 7-m above sea level) during the period October to April in two successive growing seasons (2004/2005 and 2005/2006).

Cineraria, *Senecio cruentus,* is a winter grown plant requiring approximately 150 days to reach maturity from October to April. Seeds of cineraria were carefully sown on October 23rd for each season in seed pans. The seed pans were set in the plastic house and frequently moistened. After 40 days from sowing, the seedlings were transplanted into 10 cm plastic pots and were moved to a sunny area. Four weeks later, the plants were finally repotted into the final 20 cm pots diameter and 30 cm height filled with different studied treated soil. The physical and chemical characteristics of the soil are shown in Table 2. The pinching process of the growing points was done for all plants one week before the final repotting to force them for branching. The N, P and K fertilizers were added separately as a basal dose for all the treatments in the forms of urea (46% N), calcium super phosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O), where each pot received 2 g from each fertilizer.

Three types of plant residues, i.e. rice straw, maize stalks and cotton stalks were evaluated as organic fertilizers. Main physical and chemical characteristics of composts are presented in Table 1. Composts were prepared according to Abou El-Fadl (1960). Plant residues at the rate of 0.2 Kg/pot was added during the preparation of the experiment where mixed with the soil before packing into the pots and applied one month before transplanting.

Table 1 : Physical and chemical analysis of the soil.

Physical characteristics								
Soil texture	Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	$CaCO_3$ (%)	EC dSm^{-1}	Field capacity (%)	Real density (g/cm^3)
Clay loam	8.2	30.6	27.7	33.5	2.4	0.34	32.3	2.62

Chemical characteristics								
pH	Organic matter (%)	CEC meq/100g	Available nutrients (ppm)					
			N	P	K	Zn	Mn	Fe
7.6	1.34	34.5	30.3	12.4	239	1.7	8.6	11.8

Table 2 : Some characteristics of the composted plant residues.

Compost source	Macro-nutrients (%)			Micro-nutrients (ppm)			C/N ratio	C (%)	O.M. (%)	pH
	N	P	K	Fe	Mn	Zn				
Rice straw	1.12	0.63	0.89	214	163	43	21:1	23.3	36.5	7.9
Cotton stalks	1.29	0.66	1.20	321	110	32	20:4	26.26	45.3	8.1
Maize stalks	1.32	0.47	1.42	180	212	45	16:1	21.2	40.2	7.7

Evaporation pan "Class-A" method was used for scheduling irrigation water under drip irrigation system, however, the relation between Etp and pan evaporation " Ep" can be computed as in the following form:

$$Etp = Kp\ E\ pan$$

Where: Kp represents an adjustment factor to relate free water loss to crop water loss; and, Epan represents the evaporation rate from the pan. The applied irrigation water rate was based on free surface evaporation from a class-A pan of the U.S. Weather Service. Irrigation treatments consisted of four plant-pan coefficients (Kcp1: 0.60; Kcp2: 0.80; Kcp3: 1.0, and Kcp4: 1.2). Therefore, water applications were 0.6, 0.8, 1.0 and 1.2 times of cumulative pan evaporation measured within the irrigation interval of 2-3 days. The US Weather Service Class A pan had a diameter of 121 cm, a depth of 25 cm and was placed 15 cm above the ground. Water depth was maintained between 5 and 7.5 cm below the pan rim. The evaporation rates from the pan were obtained by measuring depth of water in the pan every 24 hours. The volume of irrigation water (mm) was based on a pot diameter of 20 cm Just after planting, 10 mm was applied to all treatments every 3 days, from January 3 until January 12. Pan evaporation measurements did not start until January 13. Irrigation based on the pan evaporation began on the January 15 and ended on the April 3. No irrigation was applied in January 24 due to a rainfall depth of 10 mm, approximately the same as the typical irrigation depth.

Tap water (pH 7.2) was supplied to the pots with a drip irrigation system. The ten pots in each treatment were placed in a row and a drip tube ran across the top of the pots. Single outlet emitters were inserted into the tubing over each pot. The tubes were fixed above pots using U-shaped metal wires that were inserted into the soil such that they pushed the drip tubes close to the soil surface near the emitter point. Compost treatments with the same water application rate were irrigated from the same value. Emitters were spaced 30 cm apart, and pots also had 30 cm spacing between centers. All irrigation treatments utilized the emitters with the same flow rate and were irrigated on the same days; however, they were irrigated for different lengths of time.

Irrigation requirement was determined with a standard class (A) pan placed in the experimental field. Pan evaporation data were carefully measured every 24 hours, and the pan was frequently cleaned and filled with fresh water. The pan evaporation data was not measured on rainy days. If rain was sporadic, then ET requirement was estimated as half of that of the most recent sunny day. Irrigation frequency was every 3 days at the beginning of the experiment. On March 1, it became hotter and irrigation frequency was increased to every 2 days.

All the plants received normal agricultural practices, whenever they were needed. Sample of plants of each treatment and the most recent mature leaves under the flowering buds at color showing were taken at the end of each growing season, on April 2 to determine the following characteristics:

Vegetative growth characters:

1- Plant height (cm): was measured every 5 days by measuring the tallest portion of the haulm in each pot.
2- Number of branches per plant.
3- Dry weight (g): oven dry weight at 70°C for leaves.
4- Leaf area per plant (cm^2): was determined by the fresh weight method where certain known disks were taken from the leaves with a cork borer and weighed. The leaf area was calculated according to Koller (1972) appling following formula:

$$\text{Leaf area } (cm^2) = \frac{\text{Fresh weight of leaves}}{\text{Fresh weight of disks}} \times \text{Leaf area of the disks}$$

Flowering characters:

1- Number of flowers per plant.
2- Diameter of display per plant (cm).

Chemical composition of plants:

1- Chlorophyll a and b content (mg/g FWT): a portable leaf Chlorophyll Meter, SPAD-501, was used for greenness measurements according to Gerig and Tihpanitte (1968).
2- Total nitrogen (%) in plant and nitrogen uptake per plant (g): it was determined using micro-kjeldahl method according to Chapman *et al.* (1961).

Physical characteristics of soil:

1- Soil bulk density (Db) of soil was determined using the core method according to Vomocil (1965).
2- Saturation percentage was determined according to Dewis and Freitas (1970).
3- Total porosity (E,%) were calculated according to the equation: $E = (1 - Db/Dr) \times 100$, where; Dr: is the real density.

Statistical analysis:

The experimental design used was split-plot with the main plots arranged in a randomized complete block design with three replicates. Main plots were assigned to the irrigation treatments (0.6 Ep, 0.8 Ep, 1.0 Ep and 1.2 Ep); while, the subplots were devoted to the soil conditioner treatments at the rate of 0.2 kg/pot (rice, cotton and maize composts) and the control. Thus, the experiments included a total of 16 treatments. Each treatment consisted of 10 plants at a density of one plant per pot. The pots of each treatment of three replicates were placed on a straight line in the North-East direction.

The obtained data were subjected to analysis of variance (ANOVA) and treatment means were compared using least significant difference test as outlined by Gomez and Gomez (1983).

RESULTS AND DISCUSSION

Vegetative growth characters:

1- Effect of water stress:

Data presented in Table 3 show the effect of water stress on vegetative growth parameters, i.e. plant height (cm), number of branches/plant and leaf area (cm^2) in both seasons which were significantly increased with increasing Ep level. The mean values were increased due to Ep level up to 1.2 of pan evaporation coefficient, since it recorded of 30.9, 6.5 and 109.9 in the first season, respectively. While, the corresponding averages were 31.84, 7.0 and 111.5 in the second season, respectively. These results are in agreement with those previously reported by Conover *et al.* (1995) on diffenbachia, Gad (1999) on some ornamental shrubs, Helmy (2003) on roselle plant and El-Fawakhry (2004) on cycas plants. They found that, vegetative growth increased with increasing amount of water administrated, while reduced amounts of water reduced growth. Also, they attributed their findings by means of higher levels of acidic auxin, acidic and basic gibberlline and low levels of inhibitors recorded in plants grown under water stress conditions.

The obtained results could be attributed mainly to the suitable water amount may accelerates the physiological process in the plant. Moreover, translocation of metabolites will increase, which in turn, increases the accumulation of organic compounds in the plant and consequently increases plant growth expressed as plant height, number of branches/plant and leaf area.

2- Effect of compost application:

It is evident from the data presented in Table 3 that all tested plant residues had stimulating effect on vegetative growth i.e. plant height (cm), number of branches/plant and leaf area (cm^2) in both seasons. Maize compost medium scored the highest significant record, followed by cotton stalks and rice straw media, with no significant difference between the last two values. Relevant data averages were 21.68, 5.25 and 72.7 in the 1st season. While, the corresponding averages were 22.06, 5.91 and 74.05 in the 2nd season, respectively. These results may be related to compost content of nutrients and consequently increase plant growth. In addition, the effect of compost on vegetative growth often due to improving the structure of soil, compost also may reduce nutrients leaching. The superiority of plant growth as a result of applying maize compost can be attributed to its high content of N as well as the low C/N ratio (Table 1) which reflected on the dominant in fertilization process in comparison with the two other compost. The positive effects of composts application on vegetative growth of plant were recorded by several investigators including, Saadawy *et al.* (2005) on some indoor plants and Zarad and Mohamed (2005) on *Stevia rebaudiana*.

Table 3: Effect of water stress, compost sources and their interactions on plant growth of cineraria plants during 2004/2005 and 2005/2006 seasons.

Treatments		Plant height (cm)		No. of branches		Leaf area (cm^2)	
		1st	2nd	1st	2nd	1st	2nd
Water stress							
0.6Ep		9.869	10.19	1.5	1.8	16.03	17.05
0.8Ep		20.06	20.71	4.4	5.1	58.51	60.49
1.0Ep		21.23	20.94	5.0	5.7	77.70	79.61
1.2Ep		30.90	31.84	6.5	7.0	109.9	111.5
LSD 5%		0.60	0.43	0.53	0.46	3.65	3.69
Composts							
C0		19.22	19.82	3.66	4.00	57.8	59.96
CR		20.17	20.65	4.08	4.58	64.3	65.94
CC		20.99	21.16	4.41	5.08	67.2	68.73
CM		21.68	22.06	5.25	5.91	72.7	74.05
LSD 5%		0.60	0.43	0.53	0.46	3.65	3.69
Interaction effect between water stress and composts							
0.6Ep	C0	9.190	9.660	1.33	1.33	10.66	11.30
	CR	9.460	10.06	1.33	1.67	16.65	17.36
	CC	10.41	10.30	1.33	2.00	17.92	18.83
	CM	10.41	10.75	2.00	2.33	18.91	20.75
0.8Ep	C0	19.01	19.78	3.67	4.33	52.22	54.44
	CR	19.81	20.57	4.33	4.67	57.54	59.08
	CC	20.62	20.89	4.33	5.00	58.86	61.63
	CM	20.82	21.64	5.33	6.33	65.43	66.82
1.0Ep	C0	19.71	20.12	4.33	4.67	72.60	76.35
	CR	21.14	20.88	4.67	5.67	77.16	79.52
	CC	21.70	20.98	5.00	6.00	79.55	80.87
	CM	22.36	21.79	6.00	6.33	81.49	81.73
1.2Ep	C0	28.97	29.74	5.33	5.67	95.85	97.77
	CR	30.29	31.10	6.00	6.33	105.95	107.84
	CC	31.26	32.49	7.00	7.33	112.77	113.62
	CM	33.12	34.07	7.67	8.67	125.30	126.91
LSD 5%		NS	NS	NS	NS	7.29	7.37

Ep= Evaporation, C0=control, CR=Composting of rice straw, CC=Composting of cotton straw, CM=Composting of maize straw -differ significantly according to LSD (P=0.05), NS= insignificant.

3- Effect of interactions between water stress and compost application:

The present results revealed that the combined treatments of water stress and composts application (Table 3) affected these growth traits, however, this effect did not reach the level of significance at 5% except the leaf area parameter in any of the two seasons. However, it is clear from the tabulated data the great influence was recorded with irrigation treatment 1.2 Ep with maize compost.

This increment may be due to increasing organic matter content in the soil with amendment (composts media) application to soil, which has an important role in producing greater number of larger size pores. Since organic matter has higher water holding capacity, its addition to soil should increase the amount available water to plants.

Flowering Characters:

1- Effect of water stress:

Data recorded in Table 4 indicated that flowering parameters, as presented by number of flowers and diameter of display were greatly affected by water stress compared to control. However, plant irrigated at 1.2 of pan evaporation coefficient recorded the highest values for such flowering characters if compared with those tabulated for the other treatments. The highest significant increase in number of flowers/plant (29.38 flower) and diameter of display (27.86 cm) in the first season resulted from using of pan evaporation coefficient at 1.2 comparing with the 0.6 Ep (4.89 flower) and (8.42 cm). These results are in accordance with those reported by Abdel-Kafie (2002) on cineraria plant, who showed that during flowering stage, the plants are more sensitive to water stress which results in flowering characters reduction of water-stressed plants. Moreover, such promotive effect could be expected under this work condition, since it improved the efficiency of using water and nutrients of cineraria and also leafs surface area (transpiration and CO_2 assimilation surfaces). Thereby, the uptake and translocation of water and nutrients and the formation of bio-assimilates were activated.

Figure 1 shows the visual differences between cineraria plants in the different water treatments.

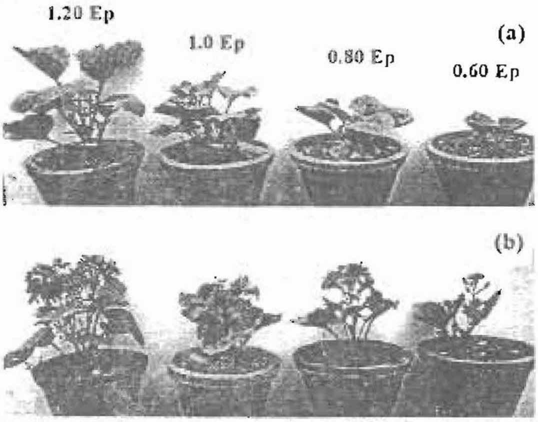

Figure 1: Cineraria plants grown under different irrigation treatments without compost treatment before (a) and after (b) flowering.

Plant appearance was unacceptable in the two lowest water treatments, was acceptable in the 1.0 Ep treatment, and the plant was flourishing in the 1.2 Ep treatment.

2- Effect of compost application:

As shown in Table (4) compost application led to high significant effect on flowering characters i.e. number of flowers and diameter of display in both seasons. Maize compost application favoured the flowering parameters of cineraria plants. Relevant data averaged 16.83 and 19.91 in the 1st season. While, corresponding averages were 18.13 and 21.11, in the 2nd season, respectively.

Table 4: Effect of water stress, compost sources and their interactions on some flowering parameters of cineraria plants during 2004/2005 and 2005/2006 seasons.

Treatments		No. of Flower		Display diameter (cm)	
		1st	2nd	1st	2nd
Water stress					
0.6Ep		4.89	4.89	8.42	8.93
0.8Ep		12.97	14.24	15.18	16.11
1.0Ep		14.66	16.49	21.02	21.87
1.2Ep		29.38	30.27	27.86	28.97
LSD 5%		0.98	0.60	0.67	0.51
Composts					
C0		13.55	14.19	16.12	16.98
CR		15.66	16.44	18.01	18.53
CC		15.85	17.13	18.45	19.27
CM		16.83	18.13	19.91	21.11
LSD 5%		0.98	0.60	0.67	0.51
Interaction effect between water stress and composts					
0.6Ep	C0	4.00	3.00	7.23	7.50
	CR	5.11	4.67	8.61	8.89
	CC	5.00	5.55	8.80	9.31
	CM	5.44	6.33	9.05	10.03
0.8Ep	C0	12.00	13.33	13.33	14.65
	CR	13.11	14.22	15.01	15.98
	CC	13.22	14.55	15.55	16.13
	CM	13.55	14.89	16.86	17.70
1.0Ep	C0	14.11	15.44	18.52	19.34
	CR	15.11	16.66	21.03	21.38
	CC	14.33	16.89	21.26	22.31
	CM	15.11	17.00	23.30	24.48
1.2Ep	C0	24.11	25.00	25.42	26.43
	CR	29.33	30.22	27.41	27.90
	CC	30.89	31.55	28.20	29.34
	CM	33.22	34.33	30.45	32.24
LSD 5%		1.96	1.20	NS	1.03

Ep= Evaporation, C0=control, CR=Composting of rice straw, CC=Composting of cotton straw, CM=Composting of maize straw -differ significantly according to LSD (P=0.05), NS= insignificant.

These results may be due to the effect of soil conditioner (compost), on increasing the availability and absorption of elements necessary for forming precursors for a class of compounds, which ultimately forms amino acids and hormones (Hewitt and Cutting, 1979). Similar trend of results was cleared by Holcomb (1984) on *Tagetes* Sp. plants. Also, these results may be due to the influence of compost on soil physical properties leading to forming more branches or enhancing the biosynthesis of flower materials consequently more flower primordia initiated. These results are in accordance with those reported by Abdel-Kafie (2002) on cineraria plants.

3- Effect of interactions between water stress and compost application:

Concerning the effect of interactions treatments, data presented in Table (4) show that flowering characters were greatly affected by the combined treatments of water stress and compost application. The highest values were recorded by plants receiving 1.2 of pan evaporation coefficient and maize compost in both seasons. These attributes might be in tight relation with the resulting promotive effects of the growing medium upon the healthy and showy cineraria plants under water stress.

Chemical composition:

1- Chlorophyll a and b content (mg/g):

1-1- Effect of water stress:

The response of chlorophyll a and b content in leaves of cineraria to the application of irrigation regimes is presented in Table 5. In both seasons, plants irrigated at the 1.2 Ep had the highest mean of chlorophylls a and b content. All differences between water treatments were significant. It is known that the water quantity can ever be a directly limiting factor in chlorophylls content. Water quantity is important in increasing the availability of nitrogen and others minerals and increasing their absorption by the plant, so increasing total chlorophylls content in leaves. These results are in accordance with those reported by Abdel-Kafie (2002) on cineraria and El-Fawakhry (2004) on cycas plants. They mentioned that water stress reduced photosynthetic pigment contents of plant compared to well-watered plants and that water stress hastens chlorophyll destruction and retards the development of chlorophyll.

1-2- Effect of compost application:

Data presented in Table 5 show that addition of compost increased chlorophyll a and b content in the fresh leaves of cineraria plants in comparison to control. The same trend was observed in both seasons. Generally, using the maize compost gave results better than the application of other compost manure to the potting mixture, but there were few significant differences between the rice and cotton compost treatments. This increment may be due to the ability of the microorganisms to produce growth regulator substances. These phytohormones play an important role in plant growth through promoting photosynthesis, translocation and accumulation of dry matter within different plant parts (Lampkin and Padel, 1994 and Kannaiyan, 2002). These results may also be due to the enhancing effect of the suitable rate of the organic manure on increasing the availability and absorption of the essential nutrient elements, especially Fe^{++}, Mg^{++} and NH_4^+ cations, which are necessary for enzymes activation and formation of chloroplasts and chlorophyll as reported by Stoffela and Kahn (2001). Similar trend of results was found by Saadawy *et al.* (2005) on some indoor plants.

Table 5: Effect of water stress, compost sources and their interactions on the contents of chlorophyll a and b (mg/g fresh weight) of cineraria plants during 2004/2005 and 2005/2006 seasons.

Treatments		Chlorophyll a mg/g		Chlorophyll b mg/g	
		1st	2nd	1st	2nd
Water stress					
0.6Ep		0.156	0.169	0.055	0.054
0.8Ep		0.176	0.188	0.093	0.093
1.0Ep		0.201	0.204	0.113	0.113
1.2Ep		0.222	0.228	0.132	0.137
LSD 5%		0.003	0.003	0.002	0.007
Composts					
C0		0.173	0.180	0.090	0.090
CR		0.190	0.199	0.097	0.100
CC		0.193	0.201	0.099	0.101
CM		0.200	0.209	0.106	0.105
LSD 5%		0.003	0.003	0.002	0.007
Interaction effect between water stress and composts					
0.6Ep	C0	0.15	0.16	0.05	0.06
	CR	0.16	0.17	0.05	0.06
	CC	0.16	0.17	0.06	0.06
	CM	0.17	0.18	0.06	0.05
0.8Ep	C0	0.16	0.18	0.09	0.09
	CR	0.18	0.19	0.09	0.10
	CC	0.18	0.19	0.10	0.09
	CM	0.19	0.20	0.09	0.10
1.0Ep	C0	0.19	0.19	0.11	0.10
	CR	0.20	0.21	0.11	0.12
	CC	0.21	0.21	0.12	0.12
	CM	0.21	0.21	0.12	0.12
1.2Ep	C0	0.19	0.19	0.11	0.12
	CR	0.23	0.24	0.13	0.14
	CC	0.23	0.24	0.13	0.14
	CM	0.24	0.25	0.15	0.16
LSD 5%		0.006	0.007	0.005	0.015

Ep= Evaporation, C0=control, CR=Composting of rice straw, CC=Composting of cotton straw, CM=Composting of maize straw -differ significantly according to LSD (P=0.05), NS= insignificant.

1-3- Effect of interactions between water stress and compost application:

Regarding the interactions, the data presented in Table 5 show that the maize compost treatment had a higher concentration of chlorophyll a and b content (mg/g) at 1.2 of pan evaporation coefficient. This could be logically true, since the rate of photosynthesis process was increased as a result of the increment in leaves content of chlorophyll. Also, the present study provided important clues to the physiological role of the compost as soil conditioner to the soil for decreasing water loss from media and possibly improving plant performance under conditions of dry soils.

2- Dry weight, nitrogen percentage and uptake:
2-1- Effect of water stress:

Data in Table 6 show dry weight (g/plant), nitrogen concentration and its uptake (g/plant) of cineraria shoot as affected by water stress in both seasons. However, it could be mentioned that the dry weight in both seasons significantly increased as the water supply increased and the results show that the effect in this respect had the same trend as for vegetative growth parameters under this study.

Table 6: Effect of water stress, compost sources and their interactions on dry weight, nitrogen % and its uptake of cineraria plants during 2004/2005 and 2005/2006 seasons.

Treatments		Dry weight g/plant		N% (in plant)		N uptake g/plant	
		1st	2nd	1st	2nd	1st	2nd
Water stress							
0.6Ep		1.75	2.74	3.36	3.57	0.06	0.10
0.8Ep		6.60	8.13	2.71	2.92	0.18	0.24
1.0Ep		5.44	7.22	2.66	2.96	0.15	0.21
1.2Ep		11.0	14.1	2.83	3.15	0.31	0.44
LSD 5%		0.77	0.78	0.13	0.19	0.02	0.02
Composts							
C0		4.78	6.21	2.61	2.86	0.12	0.17
CR		6.83	8.59	2.89	3.23	0.19	0.27
CC		6.57	8.93	3.09	3.26	0.19	0.28
CM		6.66	8.46	2.97	3.24	0.19	0.27
LSD 5%		0.77	0.78	0.13	0.19	0.02	0.02
Interaction effect between water stress and composts							
0.6Ep	C0	0.92	1.25	3.22	3.33	0.03	0.04
	CR	2.37	3.46	3.04	3.52	0.07	0.12
	CC	1.34	2.39	3.63	3.77	0.05	0.09
	CM	2.38	3.86	3.57	3.67	0.09	0.14
0.8Ep	C0	6.18	7.16	2.26	2.33	0.14	0.17
	CR	6.87	8.48	2.85	3.21	0.19	0.27
	CC	6.49	8.42	2.82	2.84	0.18	0.24
	CM	6.90	8.48	2.95	3.32	0.20	0.28
1.0Ep	C0	4.77	6.75	2.27	2.76	0.11	0.19
	CR	5.52	6.85	2.80	3.06	0.15	0.21
	CC	6.58	8.47	2.99	3.14	0.20	0.27
	CM	4.90	6.83	2.60	2.89	0.13	0.20
1.2Ep	C0	7.28	9.71	2.71	3.05	0.20	0.30
	CR	12.57	15.59	2.88	3.17	0.36	0.49
	CC	11.88	16.47	2.95	3.30	0.35	0.54
	CM	12.47	14.68	2.79	3.10	0.34	0.45
LSD 5%		1.55	1.56	0.27	0.38	0.04	0.04

Ep= Evaporation, C0=control, CR=Composting of rice straw, CC=Composting of cotton straw, CM=Composting of maize straw -differ significantly according to LSD (P=0.05), NS= insignificant.

In this respect, using the highest rate of 1.2 Ep significantly and considerably increased dry weight of shoot compared with that recorded from control or the other treatments as seen in Table 6. The suitable irrigation plays an active and important role for improving the soil moisture reserve and increase the capability of soil water holding capacity. The obtained results were supported by the finding of Zainudin *et al.*, (2003) on *Hopea odorata* and *Mimusops elengi* seedlings.

As for concentration and uptake of N, the results show that the irrigation regimes had a considerable effect on the N concentration and uptake by shoot of cineraria plant. In both seasons, the highest concentration and uptake of this elements were found in the shoots of plants irrigated at 1.2 Ep or water consumption (Etc). This result is in harmony with the findings of Lamhamedi *et al.* (2003) on black spruce.

2-2- Effect of compost application:

Data in Table 6 show that addition of compost increased dry weight (g/plant) of cineraria plant. In this concern, the medium containing maize compost was the most effective on promoting the dry weight. Similar results were obtained by El-Agamy (2006).

On the other hand, the N% and its uptake were also increased high significantly by the compost additions. The best results in this regard were recorded from the medium containing maize stalks. These positive effects of compost on N% and its uptake in case of maize stalks may be due to the effect of compost on improving soil physical properties and availability of nutrients which reflect on root growth, vegetative growth and consequently on N concentration and uptake by plant. This effect was similar with the obtained effect by El-Dissoky (2005).

2-3-Effect of interactions between water stress and compost application:

The effects of the interactions between water stress and the compost applied in different kinds on the dry weight and nitrogen uptake are shown in Table 6. It is evident from the obtained values that the superiority of dry weight, N concentration and uptake were from receiving the plants irrigation 1.2 of pan evaporation coefficient with application of maize compost.

The mean (over two years) cumulative water application depth in the irrigation water treatments were plotted in Fig. 2.

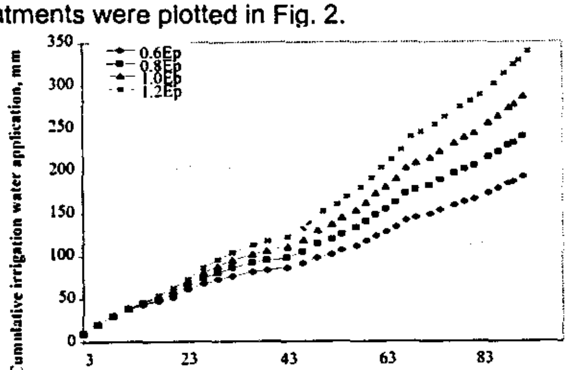

Fig. 2: Cumulative irrigation water applied for cineraria plant under different treatments

The total depth of irrigation water application were 192, 239, 287 and 333.9 mm in the 0.60 Ep, 0.80 Ep, 1.0 Ep and 1.20 Ep treatments, respectively.

Physical Characteristics:

1- Effect of water stress:

Data presented in Table 7 show that the bulk density (BD g/cm^3), total porosity (T.P%) and saturation percentage (SP) in both seasons. It seemed that the different irrigation regimes on the soil physical properties were significantly increased (in most cases). However, the differences between the mean values recorded with different irrigation regimes were not significant. These results are in harmony with those of Lamhamedi *et al.* (2003) on black spruce.

Table 7: physical properties of soil as affected by water stress, composts application and their interaction after harvesting of cineraria plants during 2004/2005 and 2005/2006 seasons.

Treatments		Bulk density g/cm^3		Porosity %		Saturation percent	
		1st	2nd	1st	2nd	1st	2nd
Water stress							
0.6Ep		1.158	1.156	55.59	55.70	66.39	66.89
0.8Ep		1.156	1.150	55.69	55.92	68.02	68.68
1.0Ep		1.178	1.151	54.83	55.87	66.38	67.74
1.2Ep		1.150	1.152	55.92	55.83	66.15	67.45
LSD 5%		NS	0.004	NS	0.157	0.969	1.067
Composts							
C0		1.193	1.189	54.28	54.41	65.10	65.51
CR		1.153	1.151	55.79	55.86	67.49	68.55
CC		1.127	1.126	56.81	56.84	67.05	68.50
CM		1.170	1.142	55.14	56.21	67.30	68.20
LSD 5%		0.033	0.021	1.265	0.786	0.939	1.161
Interaction effect between water stress and composts							
0.6Ep	C0	1.20	1.19	54.19	54.32	65.36	65.58
	CR	1.16	1.15	55.59	55.86	66.78	67.37
	CC	1.13	1.13	56.58	56.65	67.11	67.50
	CM	1.15	1.15	56.03	55.98	66.33	67.11
0.8Ep	C0	1.19	1.19	54.28	54.53	65.00	65.44
	CR	1.15	1.15	55.81	55.93	68.61	69.17
	CC	1.13	1.13	56.82	56.83	68.72	70.39
	CM	1.15	1.14	55.89	56.41	69.78	69.72
1.0Ep	C0	1.19	1.19	54.36	54.28	65.19	65.50
	CR	1.15	1.15	55.81	55.81	67.00	68.42
	CC	1.13	1.12	56.83	57.05	67.25	68.67
	CM	1.24	1.14	52.32	56.37	66.08	68.42
1.2Ep	C0	1.19	1.19	54.32	54.53	64.86	65.53
	CR	1.15	1.15	55.98	55.86	67.61	69.25
	CC	1.12	1.13	57.05	56.83	65.14	67.47
	CM	1.14	1.15	56.36	56.10	67.03	67.56
LSD 5%		NS	NS	NS	NS	NS	NS

Ep= Evaporation, C0=control, CR=Composting of rice straw, CC=Composting of cotton straw, CM=Composting of maize straw -differ significantly according to LSD (P=0.05), NS= insignificant.

2- Effect of compost application:

With regard to effect of the application of plant residues on bulk density and total porosity, data in Table 7 revealed that bulk density tended to decrease as the compost applied in the soil. Total porosity take the opposite. The lowest values of the bulk density and the highest ones of the total porosity were associated with treatment of compost. This decrease may be attributed to the high content of organic matter in these amendments, which refers to formation of the soil aggregates. Such results agree with that obtained by El-Awage *et al.* (1992) and El-Naggar *et al.* (1996).

Concerning the effect of the application of compost on the saturation percentage (SP) of the soil, data in Table 7 show an increase of the (SP%) of the soil with compost applied. These increases of saturation percentage of soil may be attributed to compost application. The present results are in accordance with these reported by El-Dissoky (2005).

3- Effect of interactions between water stress and compost application:

Data in the same Table in the two seasons indicated that the combined treatments of water regime and composts affected these soil traits, however, this effect did not reach the level of significance at 5% in any of the two seasons. Since organic matter has high water holding capacity, its addition to soil should increase the amount of available water to plants. These results are in line with that obtained by El-Maddah (2000).

Conclusions

Generally, it could be concluded from the results of this study that the suitable watering amount and frequency must be applied as better interaction treatment (120% of Class A pan evaporation depth using maize compost as soil conditioner at the rate of 0.2 kg/pot) for the vegetative growth, flowering characters and chlorophyll content in cineraria plants.

The behavior of nitrogen percentage in cineraria plants with the amount of irrigation water was not clear. On the other hand, nitrogen uptake indicated increasing trend with increasing the amount of irrigation water. Also, nitrogen uptake was improved with the addition of soil conditioners.

Soil bulk density decreased significantly by the addition with conditioners. However, the differences in soil bulk density among rice, cotton and maize composts were not significant. On the contrary, soil porosity increased with the addition of conditioners. Nonetheless, their values were not significantly affected by amount of irrigation water.

REFERENCES

Abdel-Kafie, O. M. (2002). Irrigation water regime of cineraria plants (Pericallus x Hybrida) as affected by the integrated use of hydrogels and different growing media. 2nd Inter. Conf. Hort. Sci., 10-12 Sept. 2002, Kafr El-Sheikh, Tanta University, Egypt.

Abou El-Fadl, M. (1960). Organic fertilizer and the production of plant and animal wastes. Arabic Statement Committee Press, Cairo, (In Arabic).

Ali, A.F.; A.A. Ahmed, and M.M. El-Morshedy, (2001). Effect of some organic manures on the vegetative growth and chemical composition of Khaya. 5th Arabian Hort. Conf. Ismailia, Egypt 22-24th. October.
Badran, M.S.S. (2002). Organic VS. mineral fertilization on yield and yield components of some barley varieties under sandy soil conditions. Proc. Minia 1st Conf. for Agric. & Environ. Sci., Minia, Egypt, March 25 – 28, pp: 917 – 934.
Bailey, L. H. and E. Zoe. (1976). Hortus III: A concise dictionary of plants cultivated in the United States and Canada. Revised by staff of The Liberty Hyde Bailey Hortorium, Cornell University. New York: MacMillan Publishing.
Bruce, J. R.; J. L. Chesness; T. C. Keisling; J. E. Pallas; D. A. Smittle; J. R. Stansell and A. W. Thomas (1980). Irrigation of crops in the southeastern United States, Principles and practices, USDA, SEA. Agric. Rev and Man. ARM S-9.
Chapman, H. D.; F. Paker and A. Pratt. (1961). Methods of soil analysis. Part2 A. S. A. Madison, Wisconsin.
Conover, C. A.; L. N. Satterthwatte and R. T. Poole (1995). Plant growth and NO_3-N in leachate from *Diffendachia maculate*. Hort. Abst., 65 (3): 297-2338.
Dewis, J. and F. Freitas (1970). Physical and chemical methods of soil and water analysis. Soil Bulletin 10, FAO, Rome.
El-Agamy, M. A. (2006). Evaluation of some plant residues as organic fertilizers. M. Sc. Thesis, Fac. Of Agric Mansoura Univ.
El-Awag, T. I.; A. M. Hanna and I. M. El-Naggar (1992). Effect of added amendments and plowing types on *Zea maize* root growth, sub soil mechanical impedance, chemical and physical properties of soil and ion uptake. J. Agric. Sci., Mansoura Univ., 17 (7): 2510-2520.
El-Dissokly, R. A. (2005) Effect of nitrogen fertilization and sulfur under compost application on potatoes. M. Sc. Thesis Fac. Agric, Mansoura Univ., Egypt.
EL-Fawakhry, F. M. (2004). Effect of different schedules of drip irrigation and complete liquid fertilizer rates on growth of cycas plants (*Cycas revolute*). J. Agric. Sci., Mansoura Univ., 29 (12): 7273-7285.
El-Maddah, E. I. (2000). Effect of some amendments on some physical and hydrophysical soil properties. J. Agric. Sci., Mansoura Univ., 25 (7): 4765-4775.
El-Naggar, I. M.; A. A. Darwish and A. L. El-Ghamry (1996). Response of cotton plant to application of some soil amendments and phosphorus fertilization. Menofiya J. Agric. Res., 21 (3): 715-731.
Fog, K. (1988). The effect of added nitrogen on the rate of decomposition of organic matter. Biol. Rev. 63, 433–462.
Gad, E. A. (1999). Effect of amount and frequency of watering on germination and growth of some ornamental shrubs and trees seeds. J. Agric. Sci., Mansoura Univ., 24(3) : 1255-1265.
Gerig, G. and A. Tihpanitte. (1968). Effect of nitrogen levels and micronutrients on yield of chlorophyll and mineral contents of spinach Proc. Amer. Soc. Hort. Sci., 92: 508-515.

Gomez K. A. and A. A. Gomez. (1983). Statistical procedures for Agricultural Research 2nd ed, John Willey and Sons, Inc., NY, USA, Pp 139-153.

Helmy, L. M. (2003). Studies on the effect of irrigation intervals, Bio and Chemical fertilization on roselle plant productivity. J. Agric. Sci., Mansoura Univ., 28 (5): 3927-3945.

Hewitt, J. and C. Cutting (1979). Nitrogen assimilation of plants. Academic Press, Inc.(London), LTD. 24128 Oval Road, London, NWI.

Holcomb, J.(1984). Growing in sewage sludge compositae. Hort. Abst., 54:4638.

Kannaiyan, S. (2002). Biotechnology of Biofertilizers. Alpha Sci., Int. Ltd., England. 373 pp.

Koller, H. R. (1972). Leaf area, leaf weight relationship in soybean canopy. Crop Sci., (12): 180-183.

Lamhamedi, M. S.; H. Margolis; M. Renaud; L. Veilleux and I. Auger (2003). Effect of different irrigation regimes on the growth, mineral nutrition and nutrient leaching in seedlings of black spruce. Canad. J. Forest Res., 33 (2) : 279-291.

Lampkin, N. and S. Padel (1994). The Economics of Organic Farming. An International Prespective. CAB Int., U. K. 468 p.

Mohamed, S.A. and F.M. Matter, (2001). Effect of ammonium nitrate and organic fertilizers on growth, volatile oil yield and chemical constituents of marigold (Tagetes minuta L.) Plant. Fayoum. J. Agric., Res., 15(1): 95 – 107.

Papadopoulou, E.; D.Gerasopoul, and E. Malovpa, (1996). Effect of the substrate and frequency of irrigation on growth, yeild and quality of Gerbera jamesonii Bolus cultivated in pots. Agric. Medi., 126(3): 297-302.

Raviv, M. (2005). Production of high quality composts for horticultural purposes : a mini-review. Horti. Tech., 15 (1): 52-57.

Recous, S.; D.Robin; D. Darwis and B. Mary (1995). Soil inorganic N availability: Effect on maize residue decomposition. Soil Biol. Biochem. 27, 1529–1538.

Saadawy, F. M.; B. B. Rezk-Alla and A. S. Fouly (2005). Production of some indoor plants using natural local media. J. Agric. Sci., Mansoura Univ., 30 (12): 8013-8035.

Samara, S.; R.K. Malik.;R. Mangat; S. Singh and M. Ram. (1999). Effect of rice straw burning on the efficacy of the herbicides in wheat (Triticum aestivum). Indian J. Agronomy, 44: 361-366.

Shalhevet, J.; D. Shimshi and T. Meir. (1983). Potato irrigation requirements in a hot climate using sprinkler and drip methods. Agron. J., 75: 13–16.

Stanhill, G. (2002). Is the Class A evaporation pan still the most practical and accurate meteorological method for determining irrigation water requirements. Agricultural and Forest Meteorology ,112: 233–236.

Stoffela, P. J. and B. A. Khan (2001). Compost utilization in horticultural cropping systems. Lewis Pub; New York. 401 p.

Vomocil, J. A. (1986). Particle-size analysis ' In methods of soil analysis'. C.F. Klute, A.(Ed.) part 1- Agron. 9,15,299, Am. Soc. Agron., Madison, Wisconsin, U.S.A.

Waddell, J.T.; S. C. Gupta, ;J. F. Moncrief,; C. J. Rosen and D. D. Steele. (1999). Irrigation and nitrogen management effects on potato yield, tuber quality, and nitrogen uptake. Agron. J., 91: 991–997.
Zaghloul, M.A. and E.I. Moghazy (2001). Response of some gladiolus cultivars to organic manure and NPK fertilizers in a sandy soil under Sinai conditions. Annals of Agric. Sci., Moshtohor, 39(1): 585 – 602.
Zainudin, S. R.; K. Awany and A. H. Hanif (2003). Effect of combined nutrient and water stress on the growth of *Hopea odorrata* Roxb and *Mimusops elengi* Linu. Seedlings. J. Arboriculture., 29 (2): 15-26.
Zarad, S.S. and A.E. Mohamed (2005). Effect of organic manure biofertilizer and different soil mixtures on the plant growth, yield, chemical properties and nutrient uptake of *Stevia rebaudiana* leaves. J. Agric. Sci. Mansoura Univ., 30(10): 6211 – 6220.

إستجابة نبات السنانير للإجهادات المائية ومصادر الكمبوست تحت نظام الرى بالتنقيط

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تعتبر السنانير من أهم نباتات الأصص المزهرة حيث أنها من النباتات الحساسة للجفاف ونقص الماء وتحتاج لمتابعة يومية فى الرى ورش النباتات بالماء. لذلك تم إجراء هذا البحث فى مشتل التجارب بقسم الزينة – كلية الزراعة – جامعة المنصورة خلال موسمى ٢٠٠٤/٢٠٠٥، ٢٠٠٥/٢٠٠٦ بهدف دراسة تأثير معاملات الرى والكمبوست المختلفة والتداخل بينهما على صفات النمو الخضرى والزهرى وكذلك التركيب الكيماوى لنبات السنانير.

وقد تركزت معاملات الرى المختلفة فى استخدام حوض البخر نتح الأمريكى (أ) نظراً لسهولة استخدامه، حيث اشتملت كمية مياه الرى المضافة أربعة معاملات وهى ٦٠%، ٨٠%، ١٠٠%، ١٢٠% وذلك من عمق المياه المتبخرة من حوض البخر الأمريكى (أ). أما معاملات الكمبوست فقد تضمنت ثلاثة مصادر مختلفة من القطن والأرز والذرة كمحسنات للتربة.

وقد أظهرت النتائج أن زيادة كميات مياه الرى المضافة وخاصة عند استخدام الرى بنسبة ١٢٠% من عمق البخر نتح البخر الأمريكى (أ) قد سببت زيادة فى إرتفاع النباتات ومساحة الورقة وعدد كل من الأوراق والأزهار، وكذلك قطر القرص الزهرى، كما أعطت نفس كمية الرى أفضل النتائج بالنسبة لمحتوى الأوراق من كلورفيل أ، ب، وزيادة الوزن الجاف للنبات، والنسبة المئوية للنتروجين فى النبات وكذلك الممتص، كما أكدت النتائج أن استخدام الكمبوست حقق زيادة معنوية لجميع الصفات والقياسات المدروسة السالفة الذكر.

أوضحت النتائج أيضا أن استعمال سماد الكمبوست الناتج عن مخلفات نبات الذرة أعطى أعلى القيم لمعظم صفات النمو مقارنة بكل من القطن والأرز، علاوة على تحسين خواص التربة الفيزيقية والتى ظهرت فى زيادة نسبة التشبع والمسامية ونقص فى الكثافة الظاهرية.

وعموماً فانه للحصول على نمو خضرى وزهرى جيد ومتناسق لنبات السنانير فانه يمكن التوصية بإضافة كمية من مياه الرى بنسبة ١٢٠% من عمل البخر نتح بحوض البخر الأمريكى (أ) مع استخدام سماد كمبوست الذرة كمحسن للتربة بمعدل ٠,٢ كجم/أصيص.