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Using bio-stimulating to improve growth quality and quantity of *Zinnia elegans* plants

Amira K. G. Atteya

Horticulture Department, Faculty of Agricultural, Damanhour University, Egypt.

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ABSTRACT

For improving growth quality and quantity of *Zinnia elegans* plants this experiment was done in two successive seasons of 2016 and 2017 in open field conditions. The effect of actosol, yeast extract and the combinations of them were studied on zinnia plants. All of them improved the studied parameters including vegetative characteristics such as plant height, branch length, branches number, stem diameter, leaf area, plant fresh and dry weight, as well as, rooting parameters such as root length, root fresh and dry weight, and also, improved flowering through decreasing number of days to first inflorescence opening, increased numbers of inflorescences per plant, inflorescence diameter, inflorescence fresh weight, inflorescence dry weight, vase life. In addition, they increased leaves content of total chlorophyll, total carbohydrate, macro-element (N, P and K) compared with the control treatment in both seasons, respectively. The most effective concentration of actosol as soil drench application is 10 cm^3/l across all yeast extract concentrations. While the concentration of 10 g/l yeast extract as foliar application was the best in this concern compared with the other yeast extract and control across all actosol concentrations. All combination treatments had better effects on zinnia plants compared with the control treatment. Moreover, the combination of 10 cm^3/l actosol plus 10 g/l yeast extract achieved the maximum enhancement in this study comparing with the other combination treatments including the control (0 cm^3/l actosol plus 0 g/l yeast extract) in the first and second seasons, respectively.

Key words: *Zinnia elegans,* yeast extract, actosol, vegetative growth, flowering, vase life.

Introduction

Zinnia (*Zinnia elegans*) is considered an important ornamental flower belongs to asteraceae. It is a warm climate plant originated from Mexico. Zinnia is a genus of 20 species of annual and perennial plants and notable for their solitary long-stemmed flowers that come in a variety of bright colors. Zinnia leaves are opposite with a shape ranging from linear to ovate. The inflorescences have a range of appearances, from a single row of petals, to a dome shape, with a wide range of colours such as white, yellow, orange, red, purple, and lilac colours (Dole and Wilkins, 2005). Zinnias are popular garden flowers, usually grown from seed, and preferably in fertile, humus-rich, and well-drained soil, in an area with full sun. Zinnia is mostly grown as a bedding plant and summer specialty cut flower (Nau, 1991). There for, it seems especially favored by butterflies (Baloch *et al.,* 2010).

Modern agricultural efforts tended to reduce aerial and soil pollution for the protection of public health as well as increasing beneficial microorganisms in the agricultural environment. One way to minimize the soil pollution is using bio-stimulants compounds which increase plants growth and soil fertility. Dry yeast is a natural bio-substance suggested to have stimulating, nutritional and protective functions when used on plants. Foliar application of yeast was found to increase growth, yield and quality of many crops (Mona *et al*., 2005 and Fawzy, 2007). Yeasts have been reported to be enriched source of phytohormones (especially cytokinins), vitamins, enzymes, amino acids and minerals (Khedr and Farid, 2002 and Mahmoud, 2001). It was also reported about its stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Castelfranco and Beale, 1983). It participates in a beneficial role during stress due to its cytokinins content (Barnett *et al*., 1990). Improving growth and productivity by application of active yeast extract were recorded by many researchers (El-Desuki and El-Greadly, 2006; El-Tohamy *et al*., 2008; Taha and Omar, 2010 and Ahmed *et al*., 2011)

Actosol as a biosource of humic acid reduces other fertilizer requirements, increases the water holding capacity of soil, improves soil structure, improves drainage, increases aeration of the soil, and establish a desirable environment for microorganism development (Hartwigson and Evans 2000). So,

Corresponding Author: Amira K. G. Atteya. Horticulture Department, Faculty of Agricultural, Damanhour University, Egypt. E-mail address: amira.khames@agr.dmu.edu.eg

it makes soil more fertile and productive. Meanwhile, it improves physical, chemical and biological conditions of soil (Jariene *et al*., 2008). Its direct effect on plant growth has been attributed to enhanced nutrient uptake so increases mineral contents, chlorophyll content, increases protein and of most hormonal of growth, increases penetration in plant membranes, (Chen and Aviad, 1990 and Jariene *et al*., 2008). Therefore, it promotes stimulating seeds germination, increases roots length, fresh and dry weights of plants (MacCarthy *et al*., 2001; Vaughan and Malcolm, 2002; Chen *et al*. 2004a,b). As a result it increases crops yield and helps plants to resist droughts.

Hence, the present investigation aimed to improve qualitative and quantitative characteristics of vegetative, flowering and rooting growth of Zinnia *elegans* with spraying yeast extract and soil drench application of actosol and the interaction of them.

Material and Methods

The present investigation was carried out during two successive seasons of 2016 and 2017 in an open field of a private farm in Kom-Hamada, EL-Behira governorate, Egypt, to study the effect of foliar application of some bio-stimulants on vegetative, flowering and rooting growth of *Zinnia elegans* L plants.

Plant material

The experiment was conducted during April-July 2016 and 2017. The experiment was planted in rows with 60 cm apart and the distance between the plants in the same row was 25 cm. Three seeds were planted in each hill. After 30 day the best plant of each hill was selected to complete the growth. Agricultural practices, such as irrigation, etc. were applied, wherever it was necessary and as commonly recommended. The physical and chemical properties of the soil samples were determined according to Jackson (1973) and Cottenie *et al*. (1982) as shown in table (1).

Table 1: The physical and chemical properties of the experimental soil.

Property							
O.M.	1.2	Clay%	35	**Soluble ions (meq/L)**			
CaCO3%	1.7	Texture class	Clay loam	HCO_3^-	2.5	Ca^{2+}	10.9
						Mg^{2+}	6.01
Sand	26	pH	7.9	Cl^-	9.1	Na^+	4.52
Silt %	39	ECe (ds/m)	2.2	SO^{2-}	10.5	K^+	0.31

Bio-stimulating

Yeast extracts preparation

Saccharomyces cerevisiae newly produced active dry yeast. Various concentrations of dry yeast were weighed and put with 100 cm^3 of water in glass beakers with teaspoon full of sugar. The beakers of each concentration were kept in a warm place for 10 hours. Contents of the beakers were then put in freezer at -30 ^oC for rupture of yeast cells and after that they were gotten out of the freezer and filtered into a measuring flasks and water was added to 1000 cm^3 (final volume for each one). Yeast extract solution was sprayed on plants until run of 2-3 drops of extract solution.

Actosol solutions preparation

In this experiment the "BioActivated Agro actosol® " product was used as a bio-source of humic acid. The solutions of actosol were prepared with using the different concentrations of actosol. Every concentration solved in one liter of distilled water and every hill in the same treatment took 200 ml of this solution

Bio-stimulating treatments

The work laid out is a split plot arranged in Randomized Complete Block Design (RCBD) with three replications. The main plots assigned to actosol and the sub plots deviated to yeast extract. There were three replicates for each treatment. The effect of bio-stimulating on *Zinnia elegans* L. plants was evaluated by soil drench application of actosol® (0, 10 and 20 cm^3/l) and spraying plants foliage with solutions of yeast extract (0, 5, 10 and 15 g/l) and the all possible combinations of them were done every 10 days after 30 days from planting until ten day before harvesting.. Tween 80 (0.01%) was used as wetting agent. In addition, untreated plants were sprayed with distilled water and Tween 80 (0.01%) to serve as control (Table 2). The inflorescences were harvested every day from the beginning of flowering stage.

Table 2: All different used combination of active dry yeast and actosal with the following.

Treatments			
T1	0 cm^3/L actosol plus 0 g/l yeast extract	T7	10 cm^3/L actosol plus 10 g/l yeast extract
T2	0 cm^3/L actosol plus 5 g/l yeast extract	T8	10 cm^3/L actosol plus 15 g/l yeast extract
T3	0 cm^3/L actosol plus 10 g/l yeast extract	T9	20 cm^3/L actosol plus 0 g/l yeast extract
T4	0 cm^3/L actosol plus 15 g/l yeast extract	T10	20 cm^3/L actosol plus 5 g/l yeast extract
T5	10 cm^3/L actosol plus 0 g/l yeast extract	T11	20 cm^3/L actosol plus 10 g/l yeast extract
T6	10 cm^3/L actosol plus 5 g/l yeast extract	T12	20 cm^3/L actosol plus 15 g/l yeast extract

The following data were recorded each season:

Vegetative and flowering parameters:

Plant height (cm), branch length (cm), branches number (mean of all branches per plant), stem diameter (mm) (at the base of plant), leaf area (cm^2: as mentioned by Koller, 1972), plant fresh and dry weight (g), root length (cm^2), root fresh and dry weight (g), number of days to first inflorescence opening (day), numbers of inflorescences per plant, inflorescence diameter (mm), inflorescence fresh weight (g), inflorescence dry weight (g), vase life (day) (according to Eason *et al*, 2001), leaf total chlorophyll content (SPAD unit), carbohydrate % (as percentage of dry plant as reported by Dubios *et al*. (1956), determination of macro-element (%) include nitrogen content (%), phosphorus content (%) and potassium content (%) were determined according to the methods described by Kjeldahl (Nelson and Sommers, 1973), Murphy and Riley (1962) and Isaac and Kerber (1971), respectively.

Statistical analysis

Analysis of variance with SAS software (SAS Institute, 1988) was carried out on the test treatments data. Treatments' means were compared using the LSD test at 5% level of probability. The experiment was repeated in the second year at the same site using the same steps and techniques of the first year to compare the results of the two successive seasons.

Results and Discussion

Growth characteristics

Effect of actosol soil drench application on growth characteristics of Zinnia elegans* L.*:

The growth attributes of zinnia plants were significantly affected by the applied treatments (table 3). Regarding the impact of humic acid "actosol", soil drench treatments had capacity to increase zinnia growth successfully in the first and second seasons, respectively compared with control treatment. Moreover, the addition of 10 cm^3/l actosol exhibited the most promising effect on

plant height (92.36 and 92.95 cm), branch length (48.89 and 49.19 cm), branches number (5.39 and 5.46), stem diameter (10.22 and 10.32 mm) and leaf area (16.86 and 17.39 cm^2) in two seasons, respectively compared with the other concentrations of actosol and control treatments.

***Effect of yeast extract spraying on growth characteristics of Zinnia elegans* L.:**

Variability of growth parameters of field grown zinnia in response to spray yeast extract are presented in table 3. Generally, sprayed plants performed significantly better than unsprayed ones. Application of spraying yeast extract at concentration of 10 g/l recorded the maximum values of plant height (98.19 and 95.37 cm), branch length (54.36 and 52.83cm), branches number (5.53 and 5.63), stem diameter (12.09 and 12.21mm) and leaf area (18.79 and 19.11cm^2) in the first and second seasons, respectively compared with the other yeast extract concentrations and control.

***Effect of actosol and yeast extract combination on growth characteristics of Zinnia elegans* L.:**

Regarding the combined effect of actosol and yeast extract at any concentration on vegetative growth, it was found that, sparing yeast extract ameliorate the positive effect of actosol and enhanced growth parameters of zinnia plants compared with actosol alone during two seasons, respectively. The most significant increases in growth parameters were obtained at 10 cm^3/l actosol as soil drench plus spraying 10 g/l yeast extract. So it gave the maximum plant height (102.07 and 103.09 cm), branch length (56.98 and 57.55 cm), branches number (6.29 and 6.38), stem diameter (14.47 and 14.62 mm) and leaf area (22.70 and 22.93cm^2) compared with the other combination treatments in both seasons, respectively (Table 3).

Table 3: The mean values of plant height (cm), branch length (cm), branches number, stem diameter (mm) and leaf area (cm^2) as affected with soil drench application of actosol, spraying of yeast extract and their interaction.

Treatments	Plant height (cm)		Branch length (cm)		Branches number		Stem diameter (mm)		Leaf area (cm^2)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Actosol cm^3/l										
0	81.03	80.43	41.36	40.98	4.02	4.09	6.99	7.18	11.36	11.63
10	92.36	92.95	48.89	49.19	5.39	5.46	10.22	10.32	16.86	17.39
20	88.51	91.64	46.75	48.41	4.92	5.00	10.01	10.11	15.80	16.4
L.S.D	1.72	0.88	0.88	0.44	0.26	0.30	0.64	0.60	0.47	0.41
yeast extract g/l										
0	72.97	74.40	30.99	31.59	3.43	3.45	5.89	5.95	9.45	9.85
5	86.68	89.65	47.05	48.68	4.77	4.84	8.10	8.18	14.32	14.92
10	98.19	95.37	54.36	52.83	5.53	5.63	12.09	12.21	18.79	19.11
15	91.34	93.95	50.25	51.67	5.37	5.47	10.19	10.46	16.13	16.68
L.S.D	1.73	1.67	0.87	0.87	0.21	0.23	0.72	0.70	0.80	0.74
Actosol and yeast extract combinations										
T1	70.23	71.68	28.94	29.53	3.00	3.06	3.99	4.03	8.28	8.63
T2	79.33	80.13	41.67	42.09	3.97	4.01	7.28	7.35	10.94	11.40
T3	92.90	82.42	50.71	44.99	4.77	4.86	8.67	8.75	13.48	13.64
T4	81.60	87.50	44.13	47.32	4.33	4.42	8.02	8.58	12.73	12.85
T5	76.43	77.20	33.14	33.48	3.80	3.77	6.54	6.61	10.47	10.91
T6	94.07	95.01	51.84	52.35	5.41	5.52	9.27	9.37	16.88	17.59
T7	102.07	103.09	56.98	57.55	6.29	6.38	14.47	14.62	22.70	22.93
T8	96.87	96.52	53.58	53.39	6.07	6.15	10.57	10.68	17.39	18.12
T9	72.23	74.31	30.88	31.76	3.50	3.52	7.15	7.22	9.60	10.01
T10	86.63	93.83	47.65	51.61	4.93	4.99	7.76	7.83	15.13	15.76
T11	99.60	100.60	55.40	55.95	5.53	5.64	13.13	13.26	20.20	20.76
T12	95.57	97.84	53.06	54.32	5.72	5.84	12.00	12.12	18.28	19.05
L.S.D	2.10	2.89	1.50	1.50	0.36	0.40	1.25	1.22	1.39	1.29

Plant weight

Effect of actosol soil drench on plant weight of Zinnia elegans* L.*:

Compared to the control plants, zinnia plants treated with actosol soil drench application showed significant differences on the plants growth. In addition, among the actosol concentrations, the concentration of 10 cm^3/l produced the maximum plant fresh (167.52 and 172.27 g/plant), dry weight (31.62 and 32.25 g/plant) in the first and second seasons, respectively (Table 4).

Effect of yeast extract spraying on plant weight of Zinnia elegans* L.*:

It was clear from table 4 that, the highest plant fresh weight (177.95 and 183.46 g/plant) and dry weight (34.17 and 34.65 g/plant) were measured in 10 g/l yeast extract sprayed plants compared with the control plants and the other yeast extract treatments in both seasons, respectively (Table 4).

Effect of actosol and yeast extract combination on plant weight of Zinnia elegans* L.*:

Among the treatments combination of actosol and yeast extract , it was noted that the seventh combination of 10 cm^3/l actosol plus 10 g/l yeast extract produced the heaviest plants (195.36 and 201.58 g/plant fresh weight and 38.70 and 39.24 g/plant dry weight) compared with the other combination treatments in the two studied seasons, respectively (Table 4).

Table 4: The mean values of plant fresh weight (g/plant), plant dry weight (g/plant), root length (cm), root fresh weight (g/plant) and root dry weight (g/plant) as affected with actosal soil drench application**,** yeast extract spraying and their interaction.

Treatments.	Plant fresh weight (g/plant)		Plant dry weight (g/plant)		Root length (cm)		Root fresh weight (g/plant)		Root dry weight (g/plant)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Actosol cm^3/l										
0	128.13	132.28	20.99	21.64	10.71	10.86	8.53	8.61	3.29	3.34
10	167.52	172.27	31.62	32.25	14.06	15.09	11.54	11.67	5.05	5.15
20	162.77	166.93	30.27	30.61	13.34	14.18	11.02	11.29	4.85	4.98
L.S.D.	2.42	2.38	0.44	0.70	0.87	0.43	0.98	0.21	0.45	0.27
Yeast extract g/l										
0	103.62	107.42	16.03	16.48	8.78	8.63	6.68	7.01	2.56	2.75
5	161.08	164.15	27.83	28.32	12.40	13.28	10.36	10.15	4.06	3.98
10	177.95	183.46	34.17	34.65	15.62	16.28	12.83	13.20	6.09	6.26
15	168.58	173.63	32.48	33.21	14.02	15.31	11.57	11.73	4.89	4.96
L.S.D.	3.17	2.90	0.58	0.74	0.55	0.45	0.43	0.48	0.18	0.24
Actosol and yeast extract combinations										
T1	75.87	80.21	14.16	14.60	7.03	7.53	4.95	5.21	1.99	2.16
T2	139.39	142.61	21.37	21.96	11.34	11.16	9.30	9.12	3.53	3.47
T3	152.32	157.02	25.59	25.95	12.07	12.52	10.18	10.36	3.95	4.02
T4	144.94	149.29	22.83	24.04	12.41	12.21	9.70	9.75	3.69	3.71
T5	121.50	125.15	18.03	18.28	10.17	9.66	8.07	8.04	3.04	3.17
T6	175.16	178.97	32.37	32.82	13.20	14.81	11.20	11.26	4.47	4.49
T7	195.36	201.58	38.70	39.24	18.34	18.98	14.55	14.79	7.50	7.62
T8	178.06	183.40	37.39	38.66	14.53	16.93	12.33	12.60	5.19	5.31
T9	113.48	116.89	15.89	16.56	9.13	8.71	7.02	7.79	2.64	2.93
T10	168.71	170.88	29.76	30.18	12.67	13.88	10.58	10.08	4.17	3.98
T11	186.18	191.76	38.23	38.76	16.46	17.35	13.78	14.45	6.81	7.15
T12	182.73	188.21	37.22	36.93	15.12	16.79	12.69	12.84	5.79	5.86
L.S.D.	5.50	5.02	1.00	1.28	0.96	0.79	0.74	0.83	0.32	0.42

Rooting characteristics

Effect of actosol soil drench application on rooting characteristics of Zinnia elegans* L.*:

Table (4) shows that soil drench treatment of actosol significantly improved zinnia rooting characteristics compared to control treatment. Adding 10 cm^3/l actosol gave the longest roots (14.06 and 15.09 cm) and heaviest roots fresh (11.54 and 11.67 g) and dry weights (5.05 and 5.15 g) in both seasons, respectively compared with the treatment of 20 cm^3/l actosol and control

Effect of yeast extract spraying on rooting characteristics of Zinnia elegans* L.*:

Spraying yeast extract significantly increased root growth. In addition, the maximum value of root length (15.62 and 16.28 cm), root fresh weight (12.83 and 13.20 g/plant) and root dry weight (6.09 and 6.26 g/plant) were recorded as a result of spraying zinnia plants with 10 g/l yeast extract compared with the other treatments and control in the first and second seasons respectively (Table 4).

Effect of actosol and yeast extract combination on rooting characteristics of Zinnia elegans* L.*:

For the combination effects of actosol and yeast extract, it's clearly appeared that they made significant enhancing in zinnia root growth. Moreover, the combination of 10 cm^3/l actosol plus 10 g/l yeast extract had the best values of root length (18.34 and 18.98 cm), root fresh weight (14.55 and 14.79 g/plant) and root dry weight (7.50 and 7.62 g/plant) in both studied seasons, respectively compared with all other studied combinations in this experiment (Table 4).

Flowering characteristics:

Effect of actosol on flowering characteristics of Zinnia elegans* L.*:

Table (5) shows that the application of actosol alone significantly decreased the number of days to first inflorescence opening and improved quality and quantity of zinnia inflorescences. The earlier flowering (60.47 and 59.04 day) and the greatest numbers of inflorescence per plant (7.10 and 7.57), the widest inflorescence diameter (5.26 and 5.40 mm) and longest vase life (10.76 and 9.79 day) recorded with the application of 10 cm^3/l actosol while the maximum inflorescence fresh weight (4.55 and 4.65 g) and inflorescence dry weight (0.878 and 0.898 g) were found as a result of adding actosol with the concentration of 20 cm^3/l in the first and second seasons, respectively compared with the control and the other actosol treatment.

Effect of yeast extract spraying on flowering characteristics of Zinnia elegans* L.*:

From Table (5) it may be obvious that all used yeast extract concentrations significantly accelerates and ameliorate flowering in both seasons, respectively compared to control plants. The earliest flowering (60.24 and 58.63 day), the uttermost numbers of inflorescence per plant (8.37 and 8.90), the largest inflorescence diameter (5.32 and 5.48 mm), the heaviest inflorescence fresh weight (5.13 and 5.24 g), inflorescence dry weight (0.990 and 1.011 g) and longest vase life (11.47 and 10.31 day) in the first and second seasons, respectively resulted from using yeast extract with the concentration of 10 g/l compared with the control and the other yeast extract treatments.

Effect of actosol and yeast extract combination on flowering characteristics of Zinnia elegans* L.*:

From data obtained in Table (5) it can be remarked that all treatments of actosol and yeast extract application together significantly tended to speed up and get better flowering compared with the control treatment of 0 cm^3/l actosol plus 0 g/l yeast extract in both seasons, respectively. Moreover, the combination of 20 cm^3/l actosol plus 10 g/l yeast extract had the earliest flowering (57.54 and 56.01 day). while, the combination of 10 cm^3/l actosol plus 10 g/l yeast extract had extreme numbers of inflorescences per plant (10.02 and 11.15), the biggest inflorescence diameter

(6.41 and 6.61 mm), the heaviest inflorescence fresh weight (5.83 and 5.94 g) and dry weight (1.127 and 1.147g) and longest vase life (13.28 and 11.81 day) in the first and second seasons, respectively compared with the other combinations and control treatments.

Table 5: The mean values of number of days to the first inflorescence opening (day), numbers of inflorescences per plant, inflorescence diameter (mm), inflorescence fresh weight (g), inflorescence dry weight (g) and vase life (day) as affected with actosal soil drench application, yeast extract spraying and their interaction.

Treatments.	Number of days to first inflorescence opening (day)		Numbers of inflorescence per plant		inflorescence diameter (mm)		Inflorescence fresh weight (g)		Inflorescence dry weight (g)		Vase life (day)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Actosol cm3/l												
0	66.32	64.79	5.22	5.39	3.84	3.94	3.74	3.81	0.723	0.737	8.00	8.25
10	60.47	59.04	7.10	7.57	5.26	5.40	4.53	4.63	0.876	0.893	10.76	9.79
20	62.37	60.75	6.93	7.22	4.73	4.79	4.55	4.65	0.878	0.898	10.39	9.09
L.S.D	0.67	0.89	0.44	0.31	0.10	0.13	0.30	0.31	0.059	0.060	0.24	0.22
Yeast extract g/l												
0	66.56	64.76	4.63	4.84	3.38	3.33	3.30	3.37	0.639	0.650	7.23	7.52
5	62.52	61.27	5.61	5.78	4.49	4.62	4.14	4.22	0.799	0.814	9.62	8.73
10	60.24	58.63	8.37	8.90	5.32	5.48	5.13	5.24	0.990	1.011	11.47	10.31
15	62.89	61.44	7.06	7.39	5.25	5.41	4.54	4.63	0.878	0.896	10.54	9.63
L.S.D	0.855	0.848	0.48	0.38	0.32	0.33	0.29	0.30	0.056	0.057	0.362	0.354
Actosol and yeast extract combinations												
T1	68.55	67.18	4.29	4.42	3.14	3.19	3.08	3.14	0.597	0.607	6.59	9.25
T2	65.46	64.15	5.04	5.19	3.83	3.95	3.85	3.92	0.743	0.757	8.17	7.66
T3	64.84	62.72	6.00	6.18	4.33	4.46	4.12	4.20	0.797	0.813	8.74	8.22
T4	66.44	65.11	5.55	5.76	4.05	4.18	3.92	3.99	0.757	0.770	8.51	7.89
T5	63.35	61.18	4.63	4.99	3.58	3.62	3.42	3.49	0.663	0.673	7.62	6.36
T6	60.71	59.49	6.42	6.62	4.93	5.08	4.30	4.39	0.830	0.847	10.80	9.67
T7	58.33	57.16	10.02	11.15	6.41	6.61	5.83	5.94	1.127	1.147	13.28	11.81
T8	59.51	58.32	7.32	7.54	6.10	6.28	4.61	4.70	0.890	0.907	11.33	11.34
T9	67.79	65.92	4.95	5.10	3.41	3.19	3.40	3.46	0.657	0.670	7.49	6.94
T10	61.39	60.17	5.37	5.53	4.70	4.84	4.26	4.34	0.823	0.840	9.89	8.87
T11	57.54	56.01	9.09	9.36	5.22	5.38	5.44	5.54	1.047	1.073	12.40	10.91
T12	62.74	60.90	8.31	8.87	5.60	5.77	5.11	5.21	0.987	1.010	11.79	9.66
L.S.D	1.48	1.47	0.84	0.66	0.55	0.56	0.503	0.52	0.097	0.098	0.63	0.69

Chlorophyll, carbohydrates and macronutrients:

Effect of actosol on total chlorophyll, carbohydrates and macronutrients content of Zinnia elegans* L.*:

Data shown in table (6) indicated that treated zinnia plants with actosol as soil drench application led to a significant increase in the total chlorophyll, carbohydrates and macronutrients content. The maximum total chlorophyll (31.72 and 32.26 spad unit), carbohydrates (11.844 and 12.161%) and phosphorus (0.273 and 0.283 %) contents were found under adding 10 cm^3/l actosol in both seasons, respectively. While the treatment of 10 cm^3/l actosol gave the highest contents of nitrogen (2.725%) in the first season and maximum potassium content (1.848 %) in the second one, respectively. From the other hand, using 20 cm^3/l actosol recoded the best values of nitrogen (2.731%) in the second season and highest potassium content (1.842%) in the first one, respectively compared with the other actosol treatment and control. However insignificant differences were

noticed between 10 and 20 cm^3/l actosol in chlorophyll, carbohydrates, nitrogen and potassium contents in both seasons, respectively.

Table 6: The mean value of total chlorophyll (spad unit), carbohydrates (%), nitrogen (%), phosphorus (%) and potassium (%) as affected with actosal soil drench application, spraying of yeast extract and their interaction.

Treatments.	Total ch. (Spad unit)		Carbohydrates (%)		Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Actosol cm^3/l										
0	26.01	26.72	8.948	9.085	2.209	2.276	0.231	0.238	1.358	1.398
10	31.72	32.26	11.844	12.161	2.725	2.689	0.273	0.283	1.806	1.848
20	30.99	31.12	11.760	11.898	2.657	2.731	0.265	0.277	1.842	1.781
L.S.D.	1.932	1.229	0.479	0.369	0.099	0.045	0.001	0.001	0.124	0.087
Yeast extract g/l										
0	24.23	25.09	7.93	8.19	2.340	2.442	0.239	0.245	1.342	1.436
5	29.89	29.76	10.83	11.05	2.545	2.584	0.253	0.253	1.843	1.756
10	33.11	33.93	12.83	12.85	2.619	2.658	0.272	0.298	1.828	1.820
15	31.06	31.36	11.81	12.09	2.620	2.584	0.262	0.267	1.662	1.692
L.S.D.	1.586	1.014	0.630	0.629	0.102	0.050	0.002	0.001	0.130	0.064
Actosol and yeast extract combinations										
T1	21.80	22.22	6.59	6.80	2.001	2.177	0.204	0.205	1.093	1.265
T2	26.33	26.89	9.29	8.97	2.286	2.488	0.232	0.234	1.439	1.383
T3	28.01	29.62	10.45	10.80	2.233	2.382	0.250	0.261	1.521	1.483
T4	27.89	28.15	9.46	9.77	2.315	2.286	0.234	0.250	1.380	1.462
T5	25.87	27.42	8.63	8.91	2.619	2.679	0.261	0.267	1.501	1.595
T6	32.22	31.45	12.10	12.49	2.734	2.686	0.262	0.264	2.090	1.827
T7	36.97	37.65	14.09	14.27	2.818	2.908	0.300	0.334	2.005	2.006
T8	31.84	32.52	12.56	12.97	2.731	2.779	0.268	0.269	1.765	1.770
T9	25.02	25.62	8.58	8.86	2.400	2.653	0.250	0.264	1.432	1.448
T10	31.13	30.94	11.10	11.71	2.614	2.772	0.263	0.261	2.000	2.056
T11	34.37	34.52	13.95	13.49	2.805	2.885	0.264	0.300	1.959	1.970
T12	33.44	33.41	13.41	13.53	2.813	2.861	0.283	0.283	1.841	1.843
L.S.D.	2.747	1.757	1.091	1.089	0.176	0.086	0.003	0.001	0.225	0.110

***Effect of yeast extract on total chlorophyll, carbohydrates and macronutrients content of Zinnia elegans* L.:**

It was noticed from table (6) that spraying yeast extract significantly encourage the increase of chlorophyll, carbohydrates and macronutrients content in zinnia plants in both studied seasons, respectively compared with control plants. The treatment of 10 g/l yeast extract recorded the maximum values of total chlorophyll (33.11 and 33.93 spad unit), carbohydrates (12.83 and 12.85%) and phosphorus (0.272 and 0.298 %) in both seasons and nitrogen (2.658 %), and potassium (1.820%) content in the second season. Whereas, the highest content of nitrogen (2.620 %) and potassium (1.843 %) in the first season were found with using the treatments of 15 g/l and 5 g/l yeast extract, respectively compared with the other level of yeast extract and control plants.

Effect of actosol and yeast extract combination on chlorophyll, carbohydrates and macronutrients content of Zinnia elegans* L.*:

Data in Table (6) showed that all combination treatments of actosol and yeast extract increased total chlorophyll, carbohydrates and macronutrients in two studied seasons, respectively compared with the control treatment (0 cm^3/l actosol plus 0 g/l yeast extract). in addition, combination treatment of 10 cm^3/l actosol plus 10 g/l yeast extract gave the maximum contents of total chlorophyll (36.97 and 37.65 spad unit), carbohydrates (14.09 and 14.27%), nitrogen (2.818 and 2.908 %), phosphorus (0.300 and 0.334 %) in both seasons, respectively and maximum potassium content (2.006%) in the second season. Whilst, the combination of 10 cm^3/l actosol plus 5 g/l yeast extract recorded the highest potassium content (2.090%) in the first season compared with the other combination treatments and control plants.

Discussion

Yeast extract could significantly improve rooting growth of *Zinnia elegans* L. during this study which was reflected on increasing plants length, stem diameter, number of branches and leaf area. Meanwhile, fresh and dry weights of zinnia plants were maximized also. These strong treated plants which contain higher level of total chlorophyll, carbohydrates and macronutrients were able to achieve the earliest flowering with heavier, larger and numerous flowers having longer vase life compared with untreated ones. These finding are in agreement with several researchers (Tartoura, 2001, El-Desuki and El-Greadly, 2006, Fawzy *et al*., 2010, Ghoname *et al*., 2010, Taha and Omar, 2010 and Ahmed *et al*., 2011). The positive effects of dry yeast on root, vegetative and flowering growth due to the favorable influence on metabolism and biological activity and its stimulating effect on photosynthetic pigments and enzyme activity which in turn encourage vegetative growth, improving flower formation and their set in some plants and enhancement chlorophyll formation and carbohydrates accumulation (Barnett *et al*., 1990 and El-Sherbeny *et al*., 2007). these positive effects of using active dry yeast was attributed to increase contents of different nutrients, high percent of protein, high amounts of vitamin B and natural plant growth regulators such as cytokinins (Glick, 1995 and Fathy and Farid, 1996); vitamins and amino acids in the yeast extract have physiological roles in increasing the metabolic processes role and levels of endogenous hormones i.e., IAA and GA_3 (Chaliakhyan, 1957 and Sarhan and Abdullah, 2010). Moreover, these hormones such as GA_3 promotes cell elongation and a number of plant development mechanisms and encourages numerous desirable effects such as plant height, uniform flowering, reduced time to flowering and increased flower number and size (Srivastava and Srivastava, 2007). IAA is natural auxin which stimulates cell division, cell elongation, elongation of shoot, photosynthesis, RNA synthesis, membrane permeability and water uptake also involved in many physiological processes like delayed senescence, leaf chlorophyll content, promote flowering and increased yield etc. It is also a rooting agent (Dimitrios *et al*., 2008) and also, cytokinin has important role in improving plant growth (Farooqi *et al*., 2003). So that all of these natural hormones presented in yeast extract co-operated to improve rooting, flowering and chemical constitute of zinnia plants in this work.

Using actosol which is biosource of humic acid as soil drench treatment reinforced the positive effects of spraying yeast extract so encourage vegetative and flowering growth of zinnia as well as rooting growth and increased chlorophyll, carbohydrates and N,P,K contents. This vital role of actosol may be resulting from the ability of humic acid on increasing plant uptake of needed elements thus improves plants quality and quantity. Aiken *et al*. (1985) reported that the main reason for the use of humic acid in agriculture systems is related to the ability of it to combine with metal ions. David *et al*. (1994) concluded that it may increase absorption of phosphorus indirectly through the formation of complex compounds that composes with iron. These results are in agreement with many researchers such as Sharif *et al*. (2002), Cangi *et al*. (2006), Fallahi *et al*. (2006), Akinci *et al*. (2009), Khaled and Fawy (2011) and Kamari *et al*. (2012) who observed increase in concentration of macronutrients in different parts of plants with using humus compounds. In a field experiment, Fernandez–Escobar *et al*. (1996) found that application of humic substances extract increases shoot growth of plants.

Conclusion

It was concluded that there was linear positive effect of using actosol and yeast extract on rooting, vegetative and flowering of *Zinnia elegans*. In addition, actosol and dry yeast extract combination at 10 cm^3/l actosol plus 10 g/l yeast extract proved to be an optimum level for zinnia flowering compared with the other combination treatments and control.

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