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RESPONSE OF *Calendula officinalis* L. PLANTS TO AQUEOUS ACTIVE DRY YEAST APPLICATION TYPE AND RATE IN SANDY SOILS

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ABSTRACT: The present work was carried out during two successive seasons of 2017/2018 and 2018/2019 at the Experimental Farm of El-Qassassein Horticultural Research Station, Ismailia Governorate, to study the effect of active dry yeast aqueous solution rates (2, 4, 6 and 8 g/L.) with two application types (soil drench and foliar spray) each solely or in combination to obtain the pest growth, good production of flowers yield and the highest chemical composition of *Calendula officinalis* L. plants, under sandy soil conditions. The active dry yeast levels were applied three times starting from 1st Dec. with 21 days interval between them. The flower heads were collected manually in 13 flower picking times starting from 1st Feb. with one-week intervals between them. The treatment of 4 g/L. active yeast solution in both soil drench and foliar spray and their interaction gave the highest plant height, number of branches/plant, fresh and dry weights of herb/plant, number of inflorescences/plant, fresh and dry weights of inflorescences and ray flowers (g)/plant, dry yield of inflorescences, ray flowers (kg)/fed. and total carotenoids content, during the two seasons. The interaction treatment of 4 g/L. soil drench + 4 g/L. foliar spray yielded 86.8 and 85.4 % of total productivity/year of dry weight of inflorescences (g)/plant, and 85.3 and 84.0 % of total productivity/year of dry weight of ray flowers (g)/plant from the 6th to 13th flower picking times, during the two seasons, respectively.

Key words: *Calendula officinalis*, pot marigold, active dry yeast, soil drench, foliar spray, inflorescences, ray flowers, carotenoids.

INTRODUCTION

Calendula officinalis L. (pot marigold, marigold flower, garden marigold), belonging to *Asteraceae* (*Compositae*) family, native to the Mediterranean region is an annual herb with bright and yellow to orange flowers **(Gazim, *et al.*, 2008 and Sedghi, *et al.*, 2011).**

Calendula officinalis L. is a medicinal plant that accumulates large amounts of carotenoids in the inflorescences. The yellow to orange color in the inflorescences is mostly due to the presence of carotenoids and color density depending on its content and their chemical composition. The main pigments identified were; flavoxanthin, lutein, rubixanthin, β-carotene, γ-carotene and lycopene **(Pintea, *et al.*, 2003).** Moreover, **Muley *et al.* (2009)** stated that chemical studies of pot marigold have underlined the presence of various classes of compounds, the main being triterpenoids, flavonoids, coumarines, quinones, volatile oil, carotenoids, and amino acids.

Many authors revealed that *Calendula officinalis* flower extract had significant antioxidant activity **(Herold *et al.*, 2003),** used in abdominal cramps and constipation **(Bashir *et al.*, 2006),** cytotoxic, anti-inflammatory, hepatoprotective, spasmolytic and spasmogenic **(Muley *et al.*, 2009),** antitumor, antispasmodic **(Chakraborthy and Ghorpade 2010),** reduction in blood glucose, urine sugar and serum lipids in alloxan diabetic rats **(Chakraborthy *et al.*, 2011),** anti-viral and anti-genotoxic **(Mohammad and Kashani, 2012).**

Yeast plays a beneficial role in improving the formation of flower initiation due to its effect on carbohydrate accumulation **(Winkler *et al.*, 1962).**

Furthermore, it was reported that, yeast has a stimulatory effect on cell division and enlargement, enhances nucleic acids, proteins and chlorophyll synthesis **(Kraig and Haber, 1980).** Likewise, yeast is a natural source of many growth substances (thiamine, riboflavin, niacin, pyridoxine, biotin, choline, folic acid and Vit. B_{12}) and most nutritional elements (Na, Ca, Fe, Mg, K, P, S, Zn and Si) as well as organic compounds (protein, carbohydrate, nucleic acids and lipids **(Nagodawithana, 1991).**

As for the effect of yeast on plant growth and flowering, **Ali (2001)** found that treating *Calendula officinalis* plant with the high rate (4.5 g/L) of active dry yeast increased plant height, number of branches, herb dry weight and flowering aspects. **El-Araby (2004)** revealed that early and total heads yield plant^{-1} of globe artichoke (*Cynara scolymus,* L.) and head quality characteristics i.e., average head diameter and average receptacle weight positively responded to spray with yeast at the concentration of 1 kg of row Baker's yeast: 200 liters water. **Mohamed *et al* (2005)** on *Lilium longiflorum* cv. poliana plant, found that, yeast at 3 g/L. increased flower diameter, fresh and dry weights of flowers compared with untreated plants.

The application of active dry yeast reduced at low extent the greet use of insecticides, which caused an adverse effect on growth and productivity of the plant (**Subba Rao 1984**). In the same trend, **El-Fawy and Ahmed (2015)** found that in greenhouse experiments of pepper plant, application of dry and soft activated yeast at the concentrations of 4, 6 and 8 gL^{-1} into infested soil with *Fusarium oxysporum* f. *sp*. *capsici* (FOC) and *Verticillium dahliae* (VD) one and three weeks after seedlings transplanting significantly reduced the disease severity of (FOC) and (VD) wilts. Likewise, concentration of 6 g L^{-1} of yeasts was the most effective one.

This investigation was designed to study the influence of different levels of active dry yeast as soil drench and foliar spray alone or in combination with different concentrations, aiming to obtain the highest vegetative growth, flowering yield and chemical constituent of *Calendula officinalis* L. plants. And also draw attention best production of flowers yield throughout the flower picking times.

MATERIALS AND METHODS

The present investigation was conducted at the Experimental Farm of El-Qassassein Horticultural Research Station, Ismailia Governorate, Egypt during the two successive seasons of 2017/2018 and 2018/2019 to study the effect of active dry yeast (*Saccharomyces cerevisiae*) levels as soil drench and foliar spray alone or in combination treatments for obtaining the pest growth, good production and yield of flowers as well as the highest chemical composition of *Calendula officinalis* L. plants, under sandy soil conditions.

Seeds of marigold were obtained from the Department of Medicinal and Aromatic Plants, Horticultural Research Institute, Agriculture Research Center, Dokki. Then it was sown in the nursery on 17th and 16th September in 1st and 2nd seasons, respectively. After 45 days, from planting the seedlings transplanted to the field (when it had approximately 15 cm in height and had six leaves) in plots of 2.5 m^2 (2.1 X 1.2 m) which contained the three drip irrigation lines spaced 70 cm apart. The distance between plants was 30 cm.

In this experiment active dry yeast was applied by two methods, the first was as a soil drench and the second was foliar spray, and the concentrations in the two methods were 0, 4, 6 and 8 g/L.

The experiment included 16 treatments (4 treatments of soil drench X 4 treatments of foliar spray) and replicated three times, which were distributed in a randomized complete block design. The application of active dry yeast was used in both factors by aqueous solution three times; the first was on December 1st, while the second and third were 21 days interval, during the two seasons.

The chemical and physical analysis of the experimental soil shown in Tables (1), and the analysis of active dry yeast components are illustrated in Table (2) as mentioned by **Nagodawithana (1991).**

Table 1. Chemical and physical analysis of the experimental soil

F. C. %	**11.20**	**Sand %**	**89.92**
W. P.	**2.20**	**Silt %**	**4.00**
Organic matter %	**0.42**	**Clay %**	**6.08**
pH (1 soil: 2.5 water)	**8.1**	**Soil texture**	**Sand**
EC (mmohs/cm) (1 soil: 5 water)	**0.21**		
$CaCO_3$	**2.6**	**Macroelements (ppm)**	
Soluble ions (meq/L)		**Nitrogen**	**8.1**
Ca^{++}	**1.00**	**Phosphorus**	**23**
Mg^{++}	**0.40**	**Potassium**	**108**
Na^{+}	**0.76**	**Microelements (ppm)**	
K^{+}	**0.31**	**Fe**	**2.0**
HCO_3	**1.00**	**Cu**	**--**
CL^{-}	**0.50**	**Zn**	**0.26**
SO_4	**0.97**	**Mn**	**0.80**

Table 2. Chemical composition of active dry yeast elements

Approximate composition of minerals				**Approximate composition of vitamins**			
Na	**0.12 mg/g**	**Cu**	**8.00 u/g**	**Thiamine**	**60-100 u/g**		
Ca	**0.75 mg/g**	**Se**	**0.10 u/g**	**Riboflavin**	**35-50 u/g**	**Protein**	**47**
Fe	**0.02 mg/g**	**Mn**	**0.02 u/g**	**Niacin**	**300-500**	**Carbohydrate**	**33**
Mg	**1.65 mg/g**	**Cr**	**2.20 u/g**	**Pyridoxine**	**28 u/g**	**Minerals**	**8 %**
K	**21.0 mg/g**	**Ni**	**3.00 u/g**	**Pantorhenate**	**70 u/g**	**Nucleic acids**	**8 %**
P	**13.50**	**Va**	**0.04 u/g**	**Biotin**	**1.3 u/g**	**Lipids**	**4 %**
S	**3.90 mg/g**	**Mo**	**0.40 u/g**	**Choline**	**4000 u/g**		
Zn	**0.17 mg/g**	**Sn**	**3.00 u/g**	**Folic acid**	**5-13 u/g**		
Si	**0.03 mg/g**	**Li**	**0.17 u/g**	**Vit. B_{12}**	**0.001 u/g**		

The different growth characters were recorded on 28th and 31st March during the two seasons, respectively. The flower heads were collected manually, when the petals were found in a horizontal position (Vieira *et al*., 2006), and the flower heads were pick 13 times throughout season, the first pick was carried out in the 4th and 3rd February and the other pickings applied at regular intervals each one week, and the last piking was 29th and 28th April, during the two seasons, respectively.

Data recorded

I. Vegetative growth

Plants in the middle dripper lines were randomly chosen to record the following measurements:

1- Plant height (cm).

2- Number of branches/ plant.

3- Fresh and dry weights of herb (g)/plant.

II. Flowering characters at different flower picking times

1- Number of inflorescences/ plant.

2- Fresh and dry weights of inflorescences (g)/plant.

3- Fresh and dry weights of ray flowers (g)/plant.

4- Dry weight yield of inflorescences (kg)/fed./year

5- Dry weight yield of ray flowers (kg)/fed./year

III. Chemical analysis

Total carotenoids in fresh inflorescences (mg/100 g FW) picking at April, in both seasons, were determined according to the procedure described by **Britton *et al*. (1995).**

Statistical analysis

The treatments distributed in the experiment in a randomized complete block design. The obtained data were tabulated and statistically analyzed according to **Steel and Torrie (1980)** using New L.S.D. at (5 & 1 %) for comparison between means of different treatments.

RESULTS AND DISCUSSION

I. Vegetative growth

Data presented in Table (3) reveal that, the application of soil drench and foliar spray of active dry yeast at the rate of 4 g/L. gave the tallest plants and the highest number of branches/ plant with highly significant differences comparing with other treatments. The interaction treatment of 4 g/L. soil drench and 4 g/L. foliar spray recorded the highest plant height and number of branches/ plant during the two seasons. Similar findings were obtained by **El-Naggar *et al* (2020)** who showed that plant height significantly affected with spraying *Ocimum basilicum* L. plants by dry yeast as 6 g/L. and 4 g/L. seaweed.

Concerning the effect of the application type of active dry yeast on the fresh and dry weights of pot marigold herb (g)/plant, it could be noticed from Table (4) that the treatments of 4 and 6 g/L. soil drench and foliar spray gave the highest fresh and dry weights of herb. However, the highest fresh and dry weights with highly significant recorded from both factors with the concentration of 4 g/L. in the second season. The combined treatment of 4 g/L. soil drench + 6 g/L. foliar spray resulted in the heaviest fresh and dry weights of herb, during first season, and 4 g/L. soil drench + 4 g/L. foliar spray in the second one. These findings go parallel with those obtained by **Ali (2001)** on *Calendula officinalis* plant, and **Hamed (2018)** on *Mentha spicata* L. cv. Siwa plants.

Table 3. Effect of soil drench and foliar spray of active dry yeast and their interactions on plant height (cm) and number of branches/ plant of *Calendula officinalis* L. plant during 2017/2018 and 2018/2019

Foliar spray (B) / Soil drench (A)	Control	4 g/L.	6 g/L.	8 g/L.	$M_{(A)}$	Control	4 g/L.	6 g/L.	8 g/L.	$M_{(A)}$
	First season					Second season				
	Plant height (cm)									
Control	50.0	64.0	60.7	55.7	57.6	55.0	62.0	65.7	60.7	60.8
4 g/L.	53.0	71.7	68.0	60.0	63.2	61.0	76.7	72.7	65.0	68.8
6 g/L.	53.7	64.3	64.0	57.3	59.8	58.7	71.7	69.0	62.3	65.4
8 g/L.	50.0	64.0	57.0	57.3	57.1	56.3	69.0	68.0	61.3	63.7
$M_{(B)}$	51.7	66.0	62.4	57.6		57.8	69.8	68.8	62.3	
New LSD:		A	B	AB			A	B	AB	
At 5%		1.5	1.5	3.2			2.5	2.5	5.4	
At 1%		2.0	2.0	4.3			3.3	3.3	7.1	
	Number of branches/ plant									
Control	7.3	13.7	13.3	8.3	10.7	8.3	14.3	14.7	9.3	11.7
4 g/L.	8.3	26.0	21.7	17.3	18.3	8.3	27.0	22.7	11.7	17.4
6 g/L.	9.3	22.3	12.0	10.7	13.6	10.3	23.3	16.0	13.1	15.7
8 g/L.	8.0	15.0	15.3	10.3	12.2	9.0	16.3	18.3	11.3	13.7
$M_{(B)}$	8.2	19.3	15.6	11.7		9.0	20.2	17.9	11.4	
New LSD:		A	B	AB			A	B	AB	
At 5%		0.5	0.5	1.1			0.7	0.7	1.3	
At 1%		0.7	0.7	1.4			0.9	0.9	1.8	

Table 4. Effect of soil drench and foliar spray of active dry yeast and their interaction treatments on fresh and dry weight of herb of *Calendula officinalis* L. plant during 2017/2018 and 2018/2019

Foliar spray (B) / Soil drench (A)	Control	4 g/L.	6 g/L.	8 g/L.	$M_{(A)}$	Control	4 g/L.	6 g/L.	8 g/L.	$M_{(A)}$
	First season					Second season				
	Fresh weight of herb (g)/plant									
Control	196.7	261.3	356.9	238.9	263.4	207.9	368.1	272.6	250.1	274.7
4 g/L.	323.2	620.1	705.3	519.9	542.1	334.4	716.6	629.4	531.1	552.9
6 g/L.	275.4	449.6	517.0	359.7	400.4	286.6	528.3	460.8	370.9	411.7
8 g/L.	272.6	275.4	435.6	274.0	314.4	283.8	446.8	285.2	286.6	325.6
$M_{(B)}$	267.0	401.6	503.7	348.1		278.2	515.0	412.0	359.7	
New LSD:		A	B	AB			A	B	AB	
At 5%		8.2	8.2	18.0			5.4	5.4	11.9	
At 1%		11.2	11.2	23.9			7.4	7.4	15.8	
	Dry weight of herb (g)/plant									
Control	27.6	43.7	73.6	50.6	48.9	31.1	54.1	67.9	47.2	50.1
4 g/L.	52.9	115.0	131.1	69.0	92.0	56.4	134.6	118.5	72.5	95.5
6 g/L.	48.3	78.2	96.6	64.4	71.9	51.8	100.1	81.7	54.1	71.9
8 g/L.	32.2	50.6	75.9	50.6	52.3	35.7	79.4	77.1	54.1	61.6
$M_{(B)}$	40.3	71.9	94.3	58.7		43.7	92.0	86.3	57.0	
New LSD:		A	B	AB			A	B	AB	
At 5%		3.4	3.4	7.4			5.1	5.1	11.2	
At 1%		4.6	4.6	9.8			7.0	7.0	14.9	

II. Flowering characters at different flower picking times

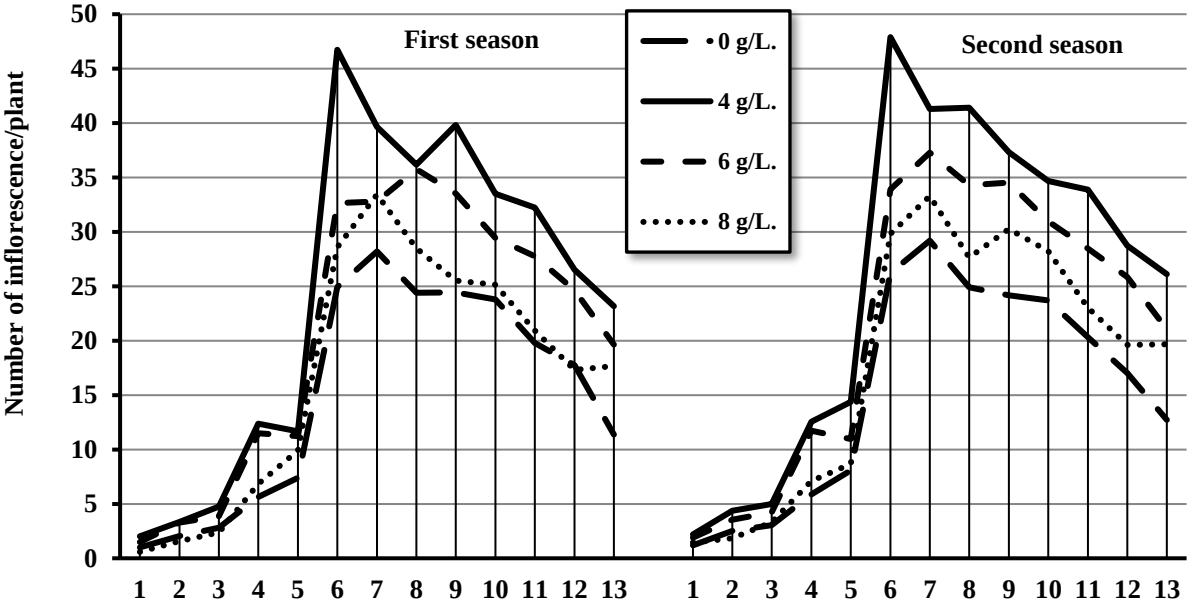
1- Number of inflorescences (g)/plant

The results presented in Fig. (1) show that the number of inflorescences (g)/plant was gradually increased with using the active dry yeast treatments from the first flower picking time to reach the maximum value in the sixth flower picking time when the plant treated with drench soil and foliar spray in the different treatments of this experiment, during the two seasons. The treatment of drench soil as 4 g/L. active dry yeast gave the biggest number of inflorescences (g)/plant, during all flower picking times in the first and second seasons.

Concerning the effect of foliar spray, the treatment of 4 g/L. gave the same trend of number of inflorescences/plant during the thirteen flower picking times in the two seasons.

Data in Fig. (2) mentioned that, the interaction treatment of 4 g/L. drench soil + 4 g/L. foliar spray of active dry yeast extract gave the highest number of inflorescences (g)/plant during all flower picking times in both seasons.

From Fig. (1) it can be observed that the highest number of inflorescence/plant under control treatment was in the seventh piking, but when using the treatment of 4 g/L. drench soil and 4g/L. foliar spray gave the highest number in the sixth piking during the two seasons. In the same manner, the control treatment gave the highest number in the tenth piking, while the interaction treatment of 4 g/L. drench soil + 4 g/L. foliar spray of active dry yeast achieved the highest results in the ninth piking, in both seasons, as illustrated in Fig. (2).



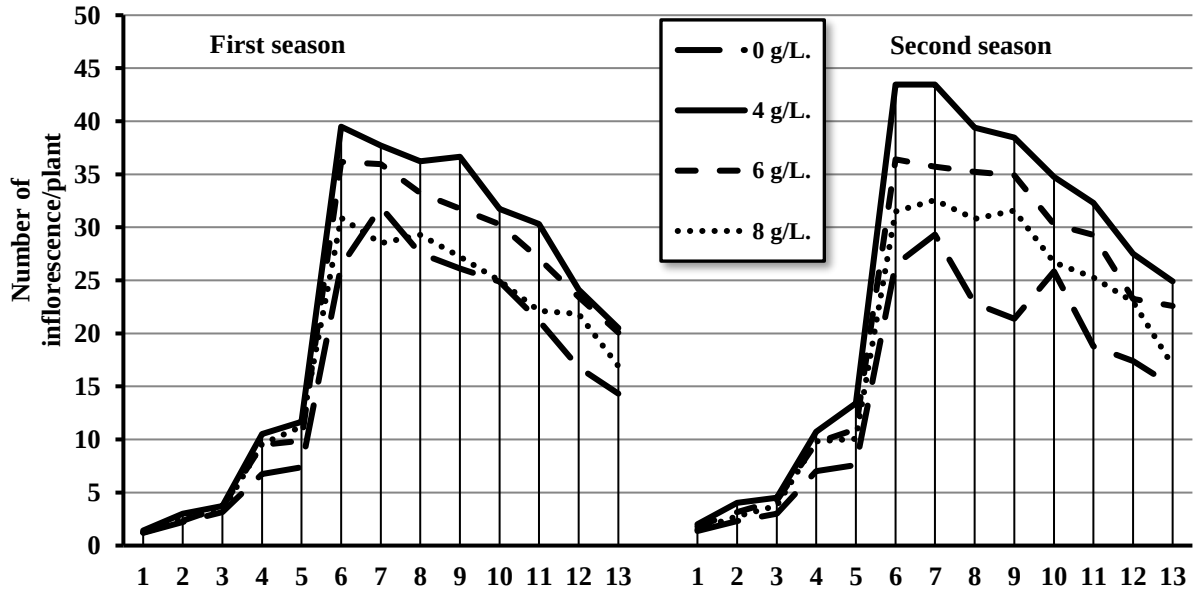


Fig. 1. Effect of soil drench and foliar spray of active dry yeast treatments on number of inflorescence/ plant of *Calendula officinalis*, L. during the two seasons of 2017/2018 and 2018/2019.

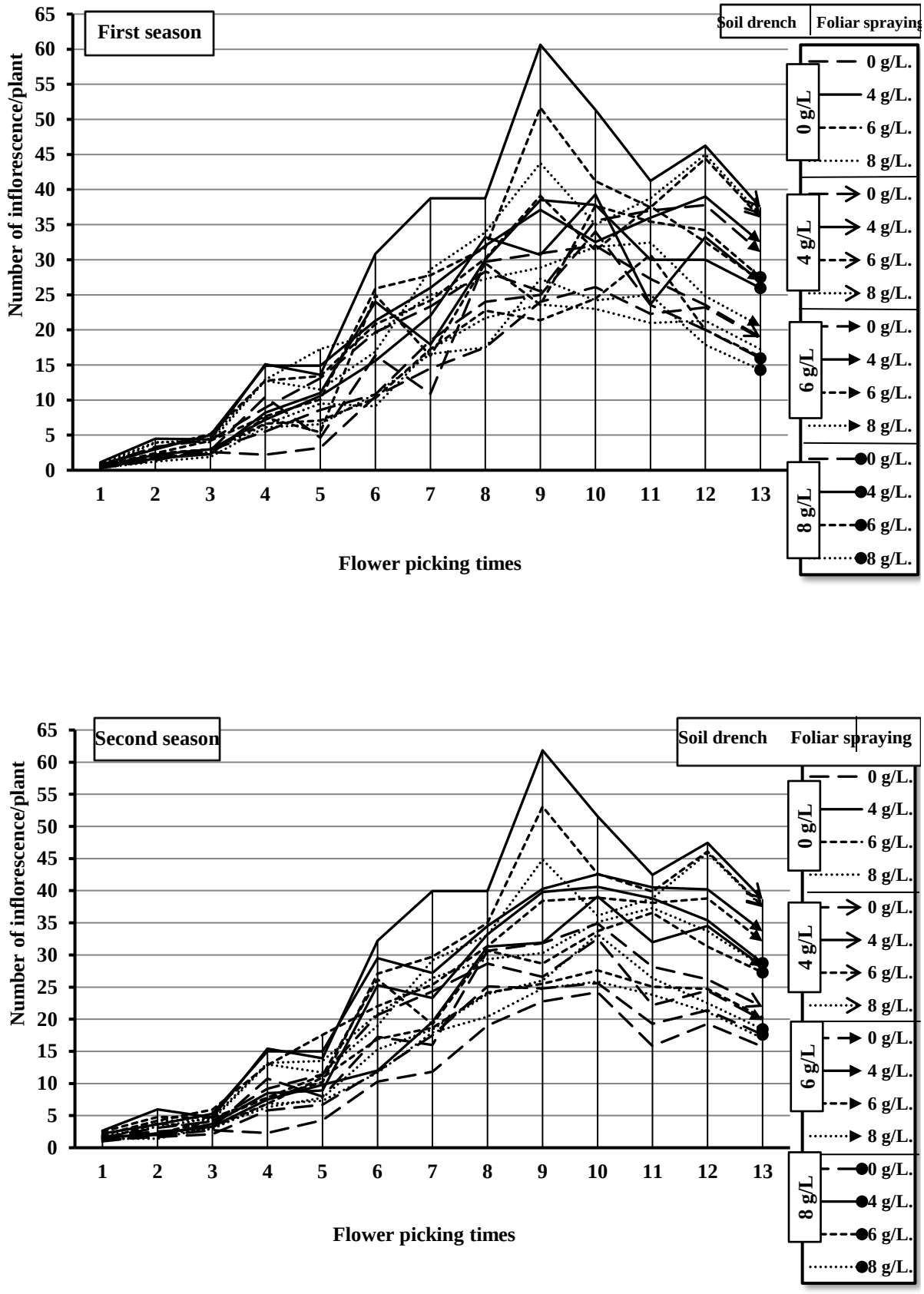


Fig. 2. Effect of the interaction treatments of soil drench and foliar spray of active dry yeast on number of inflorescence/ plant of *Calendula officinalis* L. during the two seasons of 2017/2018 and 2018/2019

2- Fresh and dry weights of inflorescences (g)/plant

As for the effect of soil drench and spray of active dry yeast treatments, the data showed in Fig. (3 & 5) state that, the highest fresh and dry weights of inflorescences (g)/plant observed in (6^{th} & 7^{th}) flower picking times, and gradually decreased when reach 13^{th} flower picking time, under all treatments. The treatment of 4 g/L. soil drench and 4 g/L. foliar spray level gave the heaviest significant fresh and dry weights during all of picking times, in both seasons.

The results showed in Fig. (4 & 6) reveal that, the combined treatment of 4 g/L. soil drench + 4 g/L. foliar spray gave the heaviest fresh and dry weights of inflorescences (g)/plant during most flower picking times, in the two seasons

The highest fresh weight of inflorescences (g)/plant under control treatment was in the seventh piking, as shown in Fig. (3), but change its place to the sixth piking when using the treatment of 4 g/L. drench soil and 4 g/L. foliar spray in the two seasons. Furthermore, the control treatment gave the highest number in the seventh piking, while the interaction treatment of 4 g/L. drench soil + 4 g/L. foliar spray of active dry yeast gave the highest results in the sixth piking, in the first season, as illustrated in Fig. (4).

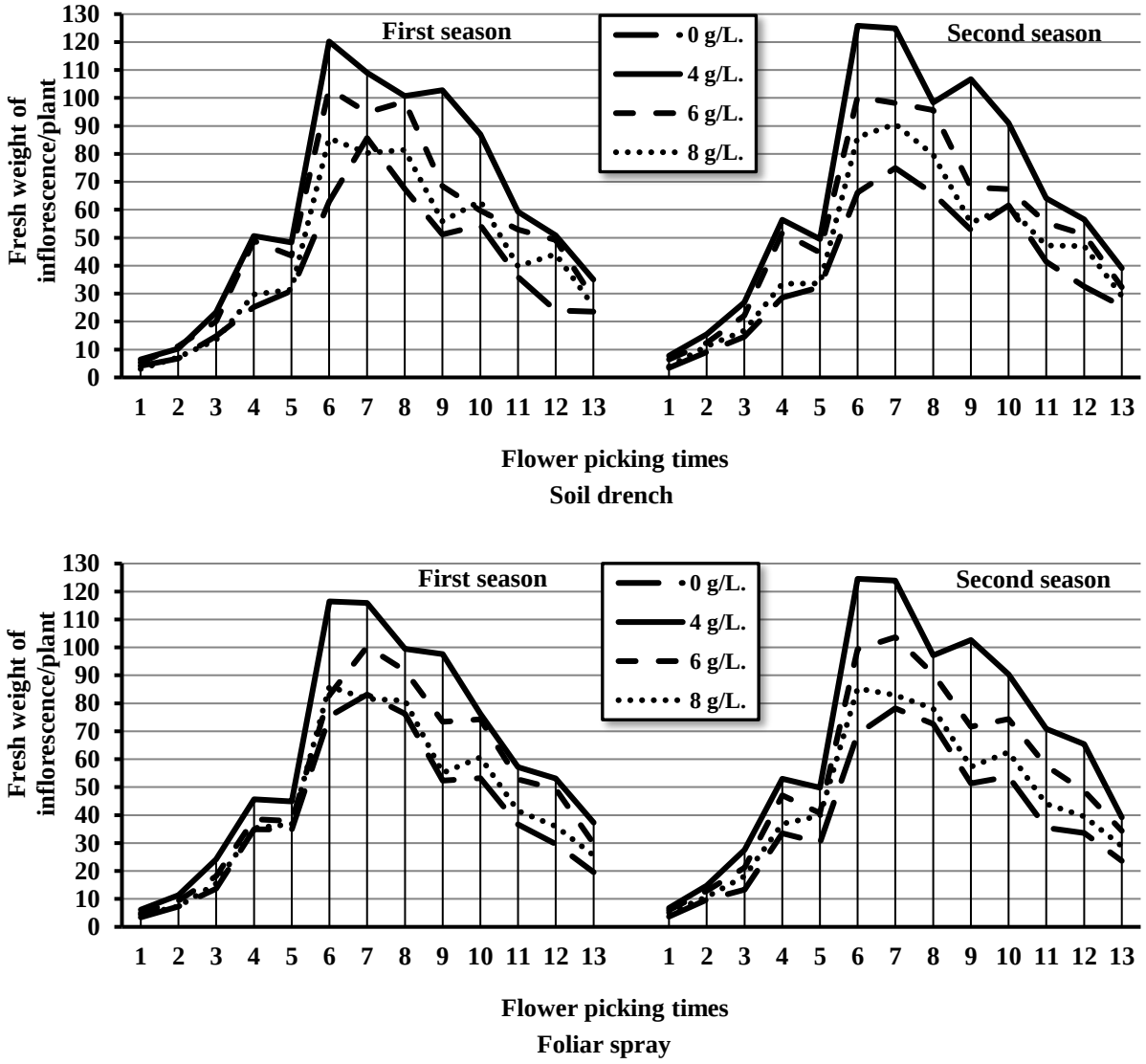


Fig. 3. Effect of soil drench and foliar spray of active dry yeast treatments on fresh weight of inflorescence (g)/plant of *Calendula officinalis*, L. during the two seasons of 2017/2018 and 2018/2019

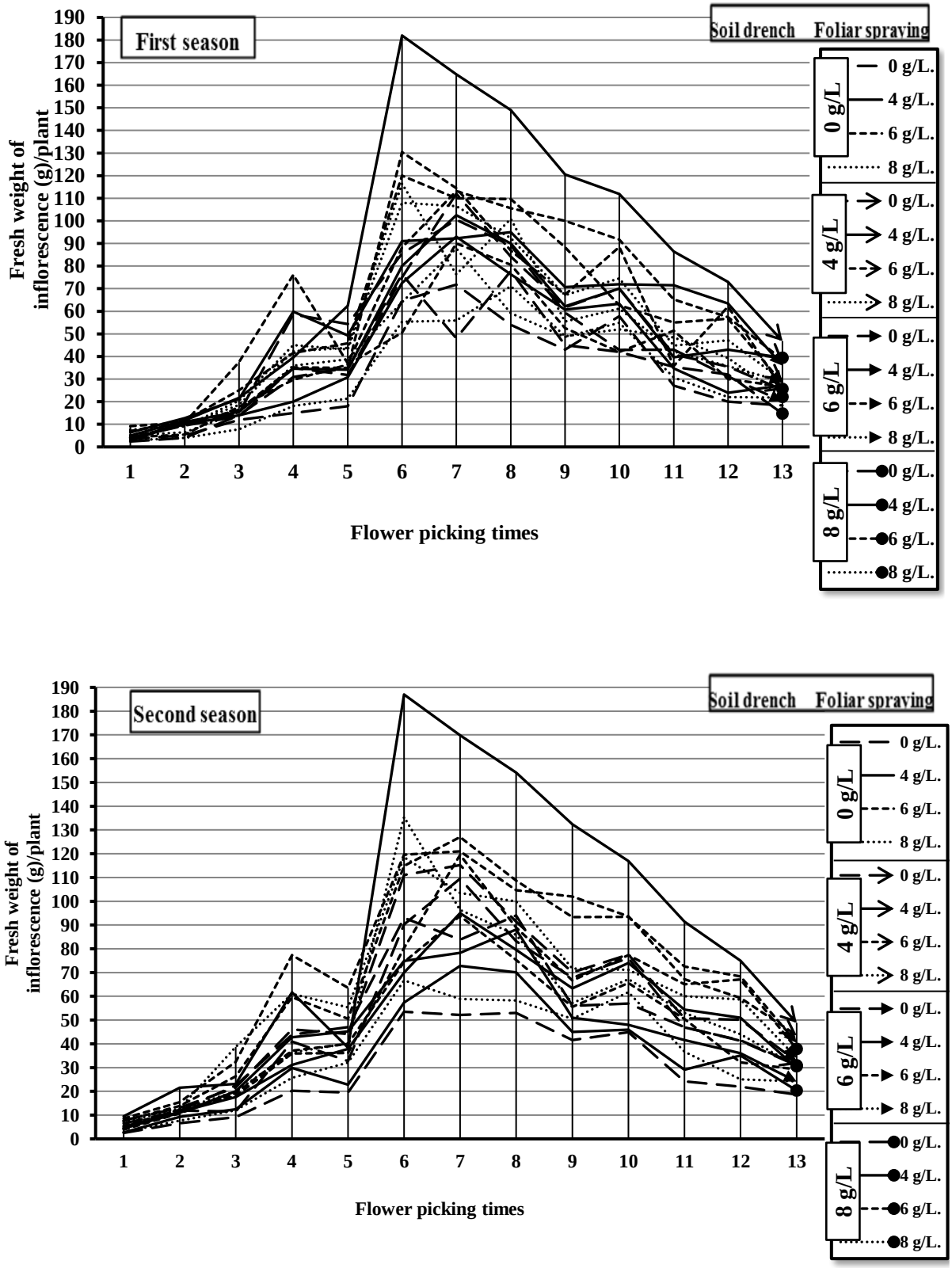


Fig. 4. Effect of the interaction treatments of soil drench and foliar spray of active dry yeast on fresh weight of inflorescence (g)/plant of *Calendula officinalis* L. during the two seasons of 2017/2018 and 2018/2019

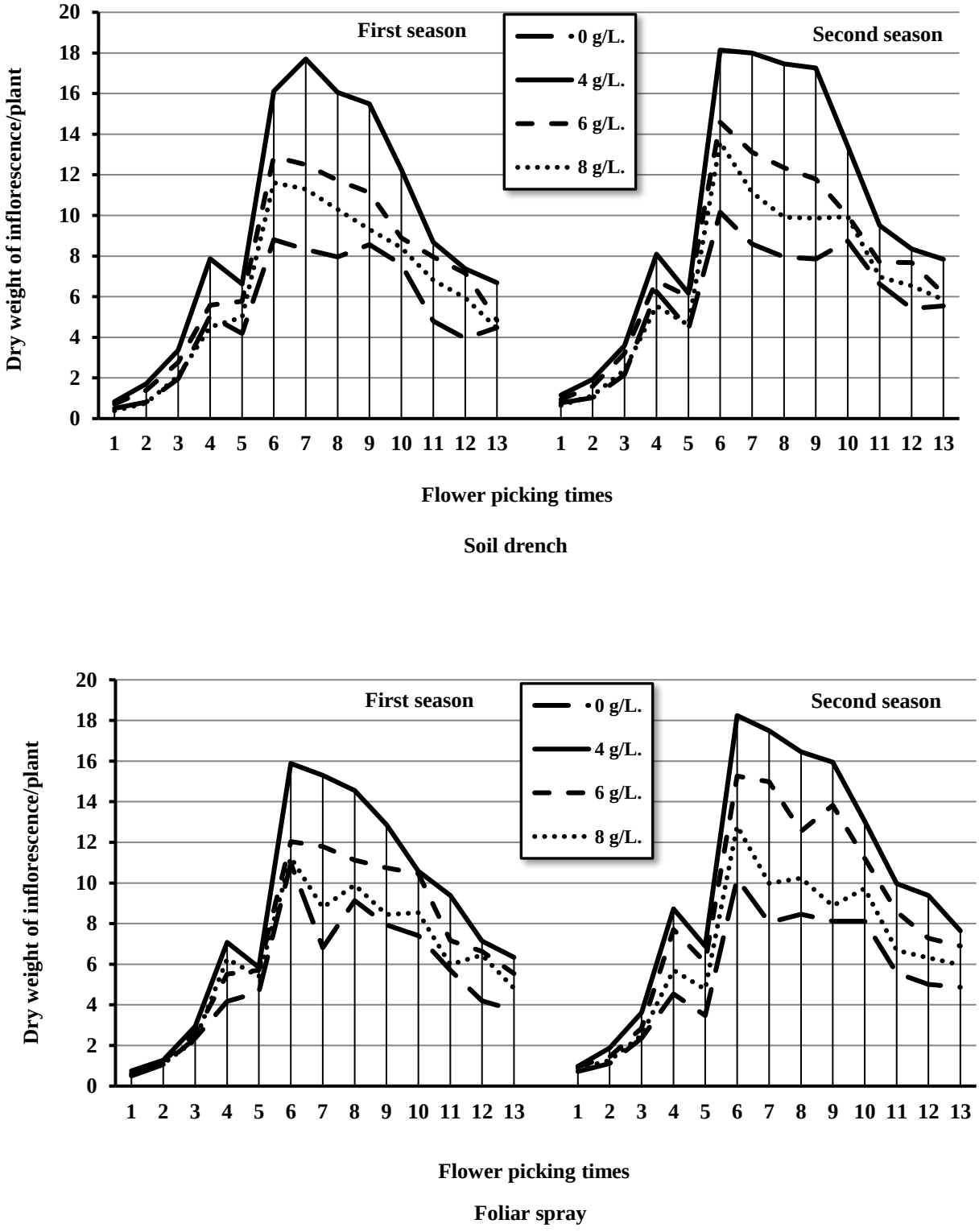


Fig. 5. Effect of soil drench and foliar spray of active dry yeast treatments on dry weight of inflorescence (g)/plant of *Calendula officinalis*, L. during the two seasons of 2017/2018 and 2018/2019.

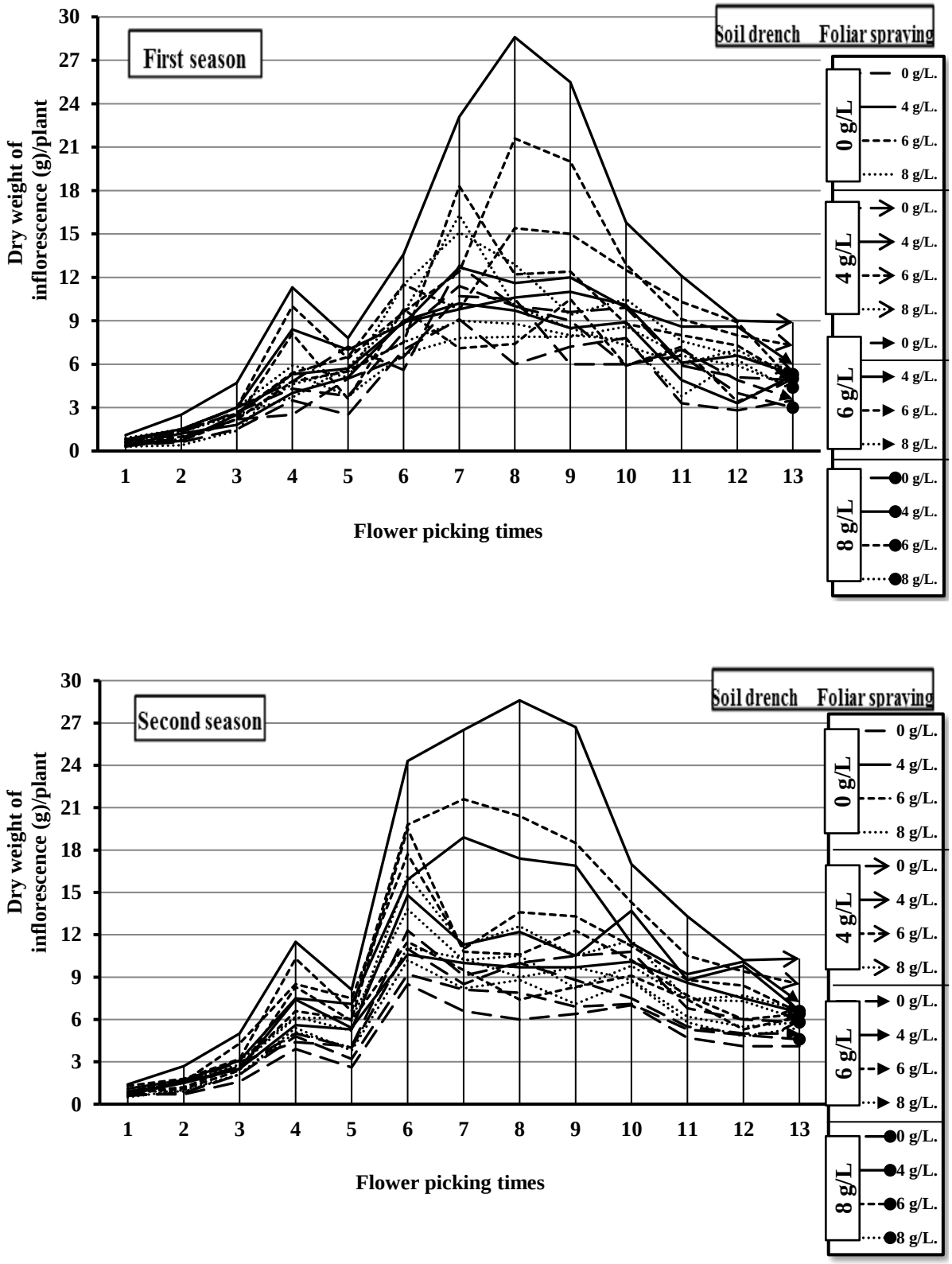


Fig. 6. Effect of the interaction treatments of soil drench and foliar spray of active dry yeast on dry weight of inflorescence (g)/plant of *Calendula officinalis* L. during the two seasons of 2017/2018 and 2018/2019

3. Fresh and dry weights of ray flowers (g)/plant

The treatment of 4 g/L. followed by 6 g/L. soil drench of active dry yeast extract significantly affected on fresh and dry weights of ray flowers (g)/plant and gave the highest values during most flowers picking times, in both seasons, as shown in Fig. (7 & 9). The data also demonstrate that, the highest fresh and dry weights were obtained from the treatment of 4 active dry yeast as foliar spray followed by 6 g/L. treatment in both seasons, respectively. There were significant differences between 4 and 6 g/L. during both studying factors. The highest weights were observed in sixth flower picking time, with all treatments, during the two seasons.

The data in Fig. (8 & 10) show that the fresh and dry weights of ray flowers (g)/plant gradually increased from the first to the sixth flower picking time, and decreased even reached the thirteen-picking time, under all active dry yeast extract treatments. The heaviest fresh and dry weights were obtained from the combined treatment of 4 g/L. soil drench + 4 g/L. foliar spray. These findings were achieved during the two seasons.

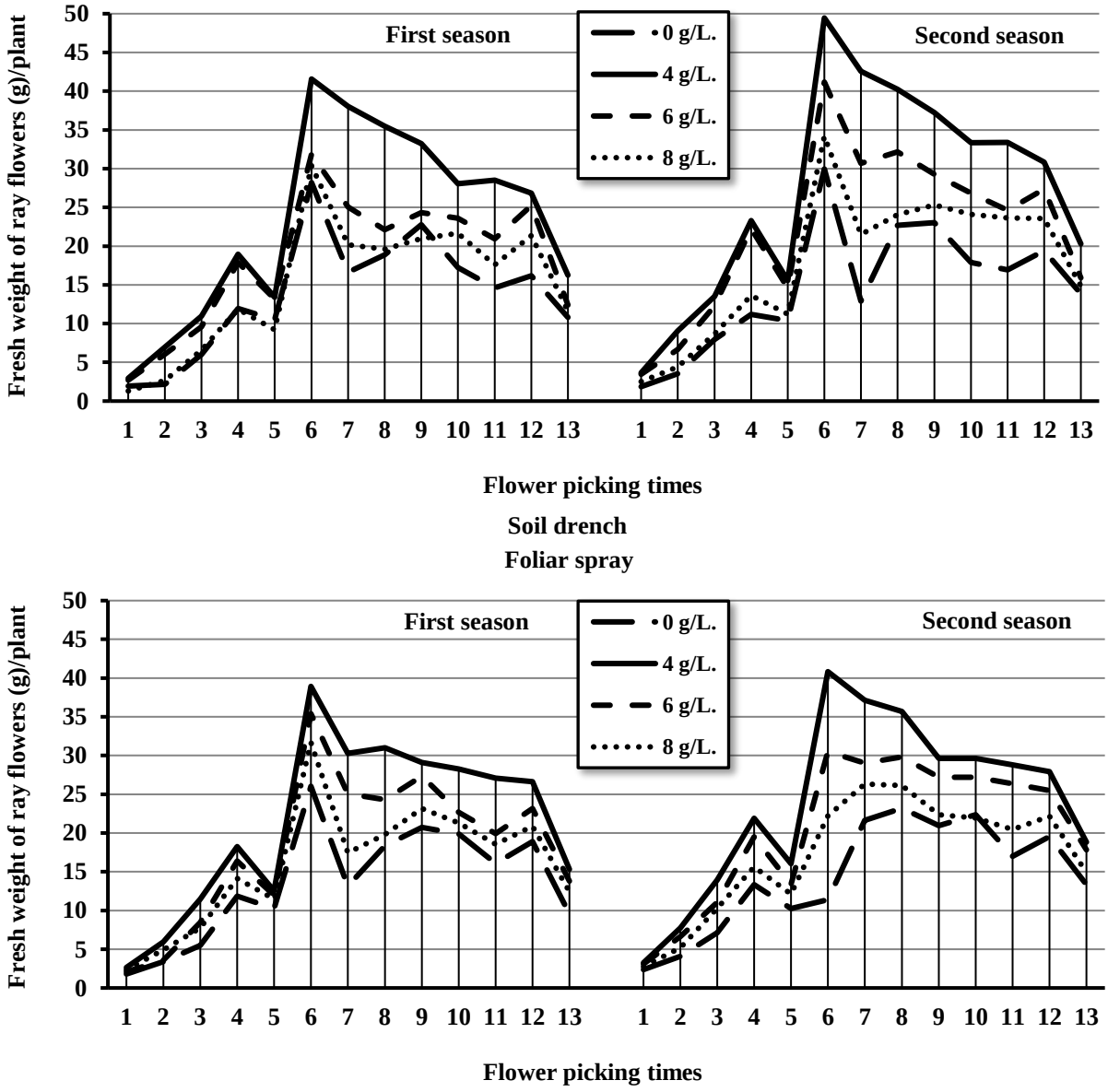


Fig. 7. Effect of soil drench and foliar spray of active dry yeast treatments on fresh weight of ray flowers (g)/plant of *Calendula officinalis*, L. during the two seasons of 2017/2018 and 2018/2019

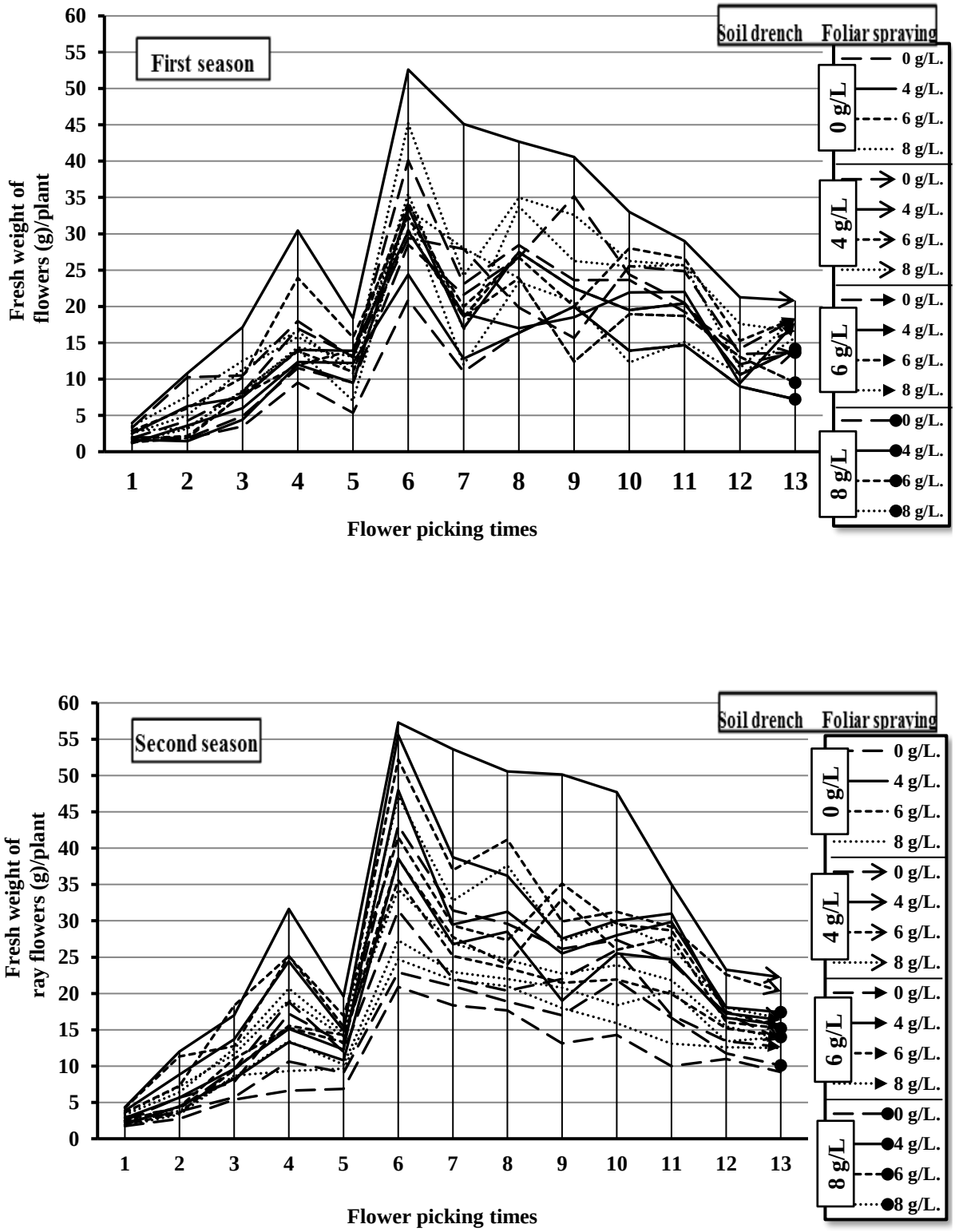
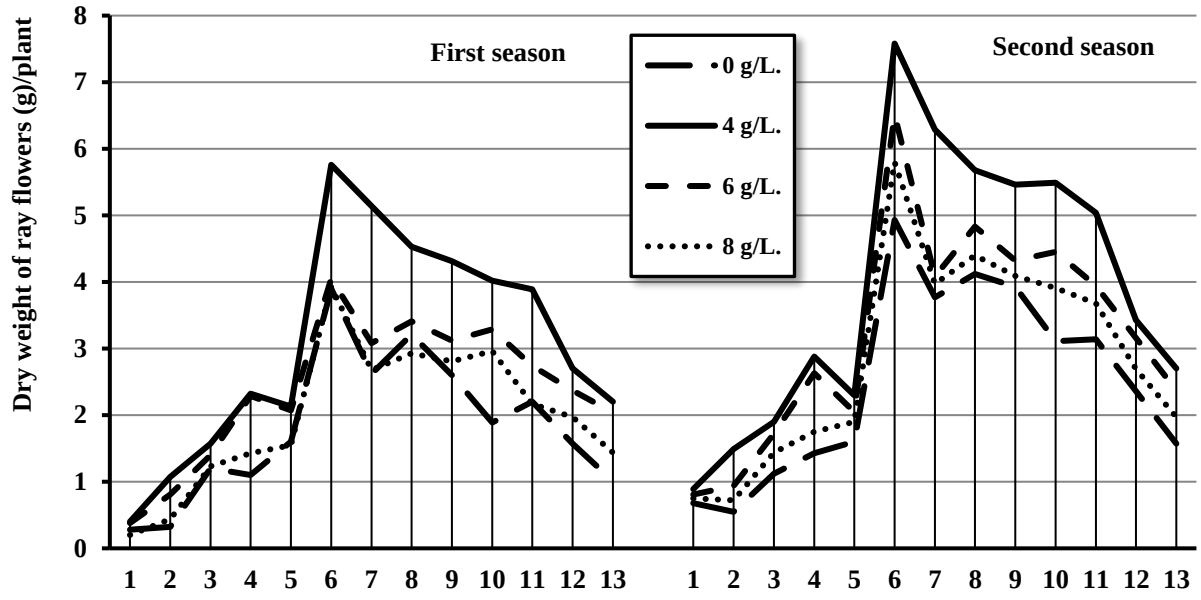


Fig. 8. Effect of the interaction treatments of soil drench and foliar spray of active dry yeast on fresh weight of ray flowers (g)/plant of *Calendula officinalis* L. during the two seasons of 2017/2018 and 2018/2019.



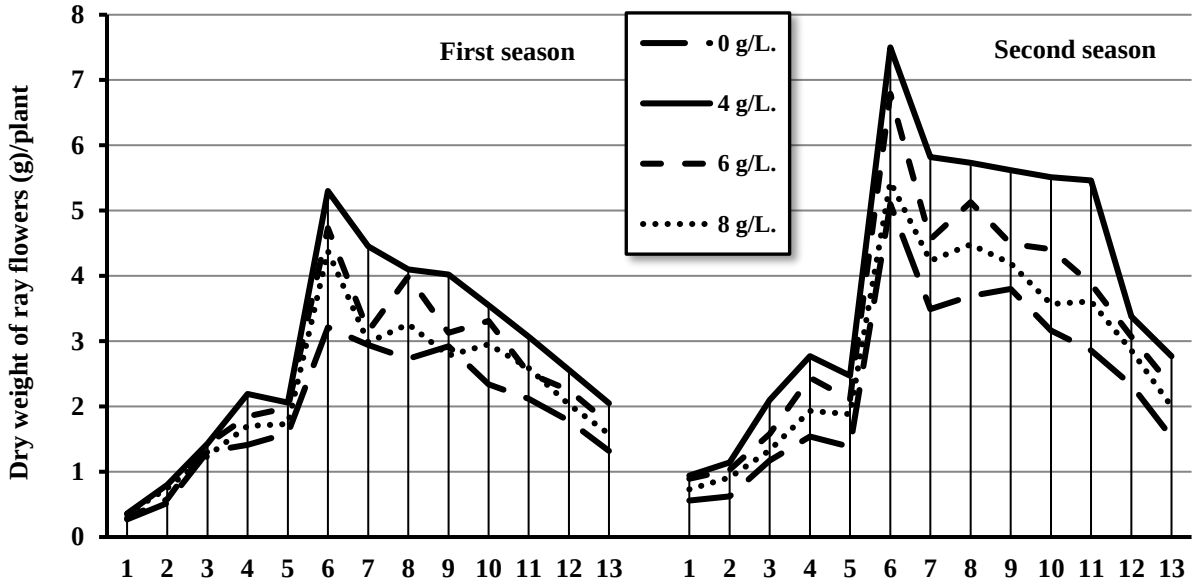


Fig. 9. Effect of soil drench and foliar spray of active dry yeast treatments on dry weight of ray flowers (g)/plant of *Calendula officinalis*, L. during the two seasons of 2017/2018 and 2018/2019

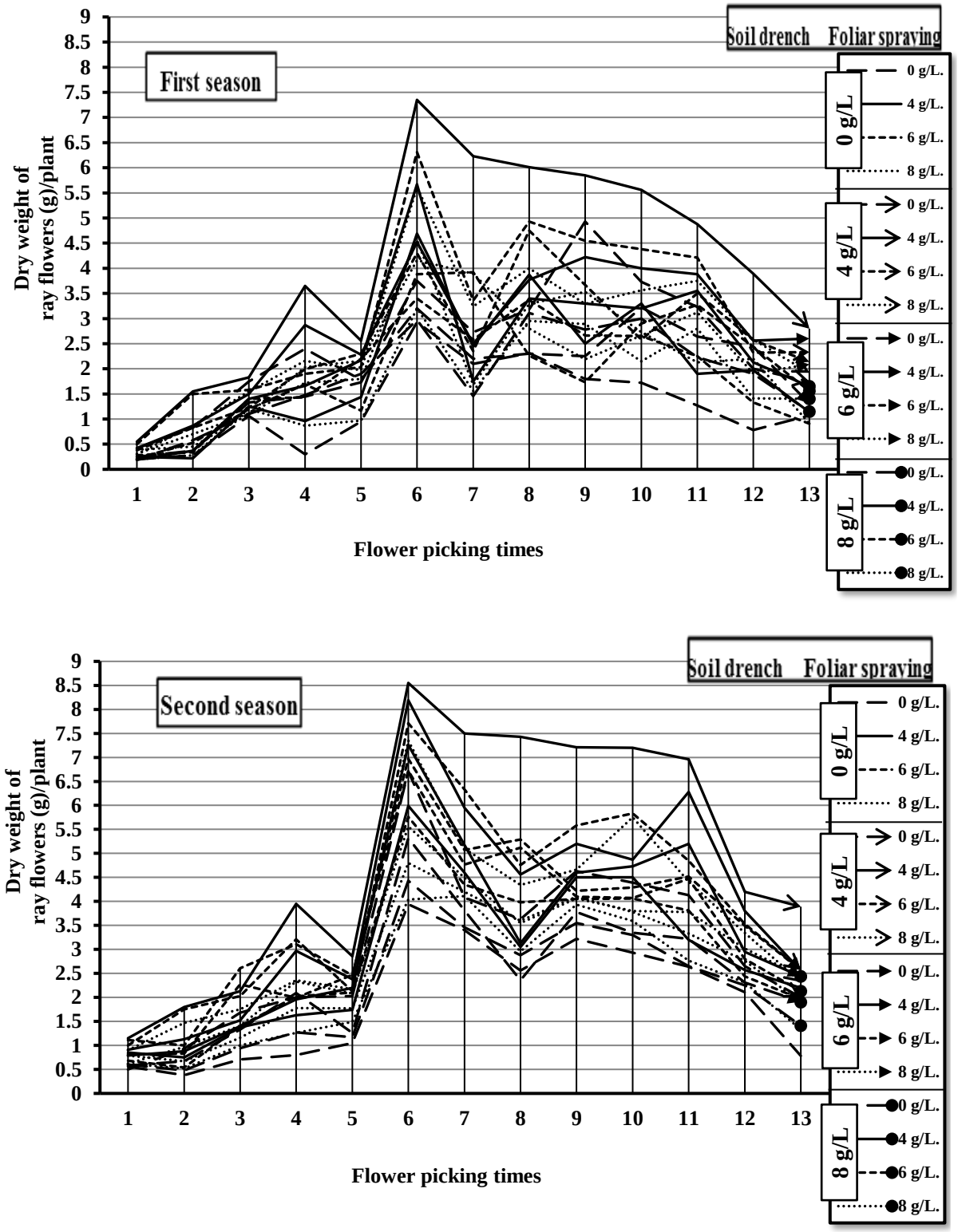


Fig. 10. Effect of the interaction treatments of soil drench and foliar spray of active dry yeast on fresh weight of ray flowers (g)/plant of *Calendula officinalis* L. during the two seasons of 2017/2018 and 2018/2019

4. Dry weight yield of inflorescences (kg)/fed./year

The data presented in Table (5) reveal that the highest dry weight yield of inflorescences (kg)/fed./yield obtained when a treated plant with the treatment of 4 g/L. followed by 6 g/L. soil drench and foliar spray too of active dry yeast during the two seasons, respectively. The differences between these treatments were highly significant in both factors, during the two seasons.

Concerning the interaction treatments, the combined treatment of 4 g/L. soli drench with 4 g/L. foliar spray followed by 6 g/L. soli drench + 6 g/L. foliar spray gave the highest results with highly significant differences between them, in the two seasons.

5. Dry weight yield of ray flowers (kg)/fed./year

The effect of active dry yeast on ray flowers dry weight (kg)/fed./year was tabulated in Table (5) and state that, the treatment of 4 and 6 g/L. soil drench and foliar spray gave the highest results, during 1st and 2nd seasons, respectively. These treatments gave 579.5 and 575.9 kg/fed./year in the first season, while it gave in the second one 746.0 and 767.6 kg/fed./year, respectively.

The combined treatments showed significant effects on yield. The highest dry weight yield of ray flowers (kg)/fed./year obtained from the interaction treatment of 4 g/L. soil drench + 4 g/L. foliar spray of active dry yeast, during the first and second seasons. The interaction treatment of 6 g/L. soil drench + 6 g/L. foliar spray of active dry yeast followed the effect of the combined treatment of 4 g/L. + 4 g/L., and the differences between them were highly significant in both seasons.

Was to get the highest productivity of the inflorescences dry weight (g)/plant beginning of sixth flower picking time until the last under the influence of the interaction treatment of 4 g/L. soil drench + 4 g/L. foliar spray of active dry yeast where gave 83.9 and 84.5% of the total plant yield in the year, during the two seasons, respectively. Similarly, the same treatment from 6th to 13th flower picking times has achieved productivity representing 80.8 and 81.7 % of the total plant production of the ray flowers dry weight (g)/plant, in both seasons, respectively.

Table 5. Effect of soil drench, foliar spray of active dry yeast and their interaction treatments on the weight of dry yield of inflorescences and ray flowers (kg)/fed./year of *Calendula officinalis*, L. during the two seasons of 2017/2018 and 2018/2019

Soil drench of active dry yeast (A)	Spray of active dry yeast (B)									
	0 g/L.	4 g/L.	6 g/L.	8 g/L.	M(A)	0 g/L.	4 g/L.	6 g/L.	8 g/L.	M(A)
	First season					Second season				
	Dry weight yield of inflorescences (kg)/fed./year									
0 g/L.	926.4	1211.8	1319.6	1160.6	1154.6	930.1	1478.9	1496.5	1181.1	1271.7
4 g/L.	1434.7	2580.7	1503.5	1219.8	1684.7	1537.2	2450.7	1944.6	1328.0	1815.1
6 g/L.	1145.8	1661.5	2111.9	1540.4	1614.9	1110.5	1998.8	2238.4	1635.8	1745.9
8 g/L.	1079.0	1393.0	1567.9	1015.1	1263.8	1073.6	1696.1	1659.5	1165.2	1398.6
M(B)	1146.5	1711.7	1625.7	1234.0		1162.8	1906.1	1834.8	1327.5	
NewLSD:		A	B	AB			A	B	AB	
At 5%		31.4	31.4	62.8			25.4	25.4	50.8	
At 1%		42.3	42.3	84.5			34.2	34.2	68.3	
	Dry weight yield of ray flowers (kg)/fed./year									
0 g/L.	275.6	429.4	452.4	440.1	399.4	409.4	606.5	671.7	489.8	544.3
4 g/L.	551.5	781.7	525.7	459.1	579.5	710.8	938.8	732.3	602.3	746.0
6 g/L.	397.8	590.1	642.6	525.6	539.0	472.3	824.2	918.4	685.8	725.2
8 g/L.	394.3	502.3	440.9	323.8	415.3	464.3	701.2	699.4	509.8	593.7
M(B)	404.8	575.9	515.4	437.1		514.2	767.6	755.4	571.9	
NewLSD:		A	B	AB			A	B	AB	
At 5%		11.9	11.9	23.7			7.0	7.0	14.0	
At 1%		16.0	16.0	32.0			9.4	9.4	18.8	

III. Chemical constituents

Total carotenoids (mg/100 g FW)

Data presented in Table (6) show that the highest content of total carotenoids was observed when the plants were treated with 4 g/L. soil drench of active dry yeast, during the two seasons. In the same manner, the treatment of 4 g/L. foliar spray gave the same trend, in the two seasons.

The interaction treatment of 4 g/L. soil drench + 4 g/L. foliar spray gave the highest total carotenoids content in the first and second seasons. This treatment had highly significant differences over all the other interaction treatments, in both seasons.

A similar trend was resulted by **Abd El-Khalek (2017)** who mentioned that the highest values of carotenoid content in fresh leaves of evening primrose (*Oenothera biennis*) obtained using the triple combination of cattle manure at 15 m^3/fed., yeast at 8 g/L water and humic substances at 1 L/fed.

Table 6. Effect of soil drench, foliar spray of active dry yeast and their interaction treatments on carotenoids content (mg/100 g FW) in inflorescences of *Calendula officinalis*, L. during the two seasons of 2017/2018 and 2018/2019

Soil drench of active dry yeast (A)	Spray of active dry yeast (B)									
	0 g/L.	4 g/L.	6 g/L.	8 g/L.	$M_{(A)}$	0 g/L.	4 g/L.	6 g/L.	8 g/L.	$M_{(A)}$
	First season					Second season				
	Carotenoids content (mg/100 g FW)									
0 g/L.	36.0	116.5	126.9	91.8	92.8	40.0	137.3	148.9	132.1	114.6
4 g/L.	126.8	300.8	196.6	160.6	196.2	135.0	316.4	256.8	210.9	229.8
6 g/L.	70.7	237.3	165.6	155.0	157.1	84.0	252.9	207.2	179.1	180.8
8 g/L.	45.0	211.9	132.0	100.9	122.5	56.0	230.1	192.1	143.8	155.5
$M_{(B)}$	69.6	216.6	155.3	127.1		78.8	234.2	201.3	166.5	
New LSD		A	B	AB			A	B	AB	
At 5%		2.8	2.8	6.2			6.6	6.6	14.4	
At 1%		3.8	3.8	8.2			8.9	8.9	19.1	

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