INFLUENCE OF SOWING DATE, IRRIGATION RATE AND ACTIVE DRY YEAST TREATMENTS ON GROWTH AND ESSENTIAL OIL OF MARJORAM (*MAJORANA HORTENSIS*, MOENCH) PLANTS

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ABSTRACT

This investigation was carried out during the two successive seasons of 2003/2004 and 2004/2005 aiming to study the effect of planting date (Sept.27th, Oct. 12th, Oct.27th and Nov.11th), drip irrigation system with emitters 2,4 and 6 L/h, drenching with active dry yeast at concentrations of 0.0, 3.0 and 6.0 g/l and their interactions on herb and leaves dry weight among all the three cuts and total dry yield of herb and leaves /plant and essential oil % in leaves among the three cuts and essential oil yield in all cuts, as well as total essential oil yield /plant of marjoram plants. Obtained results revealed that:

1- Effect of sowing date

Early sowing dates particularly the first sowing date gave the highest herb and leaves dry weight, as well as essential oil yield every cut, also, this time in the third cut has recorded the best results of these previous parameters. Moreover, early planting time specially the first date recorded best results concerning total yield/plant of herb and leaves and essential oil. Also, early sowing date particularly the second date in the second cut gave the best results of essential oil percentage compared to other cuts.

2- Effect of irrigation rates

Application of medium rate of irrigation resulted maximum herb and leaves dry weight in all cuts, also, this rate in the first and the third cuts of both seasons, respectively gave the best essential oil

yield. Moreover, the same rate in the third cut recorded highest herb and leaves dry weight comparing to other cuts. The medium rate of irrigation in the second cut of the first season only gave maximum values of essential oil percentage, meanwhile the influence of irrigation treatments on oil % in other cuts for the two seasons was not significant. Also, the medium rate in the first and the third cuts for the two seasons, respectively produced best essential oil yield. Furthermore, the medium rate recorded highest values of total yield of herb, leaves and essential oil in comparison with the low and the high irrigation rates.

3- Effet of active dry yeast

Utilizing of high concentration led to obtain maximum values of herb, leaves dry weight and essential oil percentage and yield in all cuts. In addition, the same concentration in the third cut yielded highest herb and leaves dry weight, as well as, essential oil yield compared to other treatments among the three cuts. While, the best results of essential oil % were recorded as a result of drenching the plants with the high concentration in the second cut, also using of this concentration gave the best total yield/plant of herb, leaves and essential oil.

4- Effect of interaction between sowing date (S) × irrigation rates(I)

The data showed that the best herb and leaves dry weights were obtained due to S_1I_3 or S_1I_2 treatments in the third cut compared to other ones in the three cuts. Applying of S_2I_2 followed by S_2I_1 in the second cut gave highest values of essential oil % in the first season. Meanwhile, S_2I_3 or S_2I_2 in the first cut resulted highest essential oil % in the second season.

Moreover, application of S_1I_2 followed by S_1I_1 in the third cut yielded best results of essential oil yield in the first season. Treatments of S_1I_3 or S_1I_2 in the above same cut recorded best results concerning essential oil yield in the second season. Maximum values of total dry yield/plant of herb were detected due to application of S_1I_3 or S_1I_2 in comparison with other combinations. The best of total dry yield/plant of leaves was observed from S_1I_2 followed by S_1I_1 in the first season. In the second season, the same results were obtained due to applying S_1I_3 or S_1I_2. Moreover, the best results of total yield/plant of essential oil were obtained as a result of application of S_1I_3 or S_1I_2 in the second

season only, while the effect of the interaction on essential oil yield/plant in the first season was not significant.

5- Effect of the interaction between sowing date (S) × active dry yeast (Y)

Application of S_1Y_3 followed byS_1Y_2 in the third cut led to obtain the highest herb dry weight compared to other treatments in all cuts. The same results were recorded concerning leaves dry weight and essential oil yield in the first season only, but the influence of these combination treatments on leaves weight was not significant among all cuts in the second season. The aforementioned treatments in the second cut of the second season produces best results of essential oil yield. Applying of S_2Y_3 followed byS_1Y_3 gave best essential oil % in the second cut of the second season, while the combined effect on essential oil % was not significant in other cuts of both seasons. Also, treatments of S1Y3 followed by S1Y2 recorded best results of total herb dry yield/plant and total essential oil yield/plant. The same results were detected from these treatments concerning best results of total yield/plant of leaves in the first season only, but the interactions effect on leaves dry yield/plant was not significant in the second season.

6- Effect of the interaction between irrigation rates (I) and active dry yeast (Y)

Applying of I_2Y_3 followed by I_3Y_3 in the third cut of the second season gave highest herb dry weight, in addition the combined effect in other cuts for the two seasons was not significant. These combination treatments had no significant effect concerning leaves dry weight and essential oil yield in all cuts for the two seasons. Using of I_2Y_3 followed by I_1Y_3 in the second cut only of both seasons resulted maximum values of essential oil % but the interaction effect in other cuts of the two seasons was not significant. I_2Y_3 followed by I_3Y_3 treatments in the first season gave highest total dry yield/plant of herb , while the combined effect was not significant in the second season. Also, the interaction effect on total yield/plant of leaves dry and essential oil was not significant in the two seasons.

7- Effect of the interaction between sowing date (S) × irrigation rates (I) × active dry yeast (Y)

Application of $S_1I_3Y_3$ followed by $S_1I_2Y_3$ in the first cut of the first season recorded best results of herb dry weight, but the combined effect was not significant in other cuts for both seasons.

The best results of essential oil yield were obtained due to Appling $S_1I_1Y_3$ or $S_1I_1Y_3$ in the first cut of the first season whereas; the interaction effect was not significant in all cuts for both seasons.

Also, the interaction effect on leaves dry weight in all cuts, total yield /plant of leaves dry and essential oil was not significant in the both seasons. Applying of $S_1I_3Y_3$ followed by $S_1I_2Y_3$ yielded the best results of total yield/plant of herb dry in the first season, meanwhile, the effect of these interactions was not significant in the second season. The maximum values of essential oil % were obtained due to applying $S_2I_2Y_3$ followed by $S_2I_2Y_2$ in the first cut of the first season only, while the combined effect was no significant in other cuts for both seasons.

INTRODUCTION

Marjoram (*Majorana hortensis*, Moench) is perennial herbaceous aromatic and medicinal plant cultivated in the region of Mediterranean. It belongs to family Lamiaceae (Labiatae). Marjoram herb and its essential oil have been utilized in diarrhea and intestinal colic. The herb has a popular flavoring in food industry (Stary and Jirasek, 1982). It is used in stomach, sinewy disease and aids in healing obstructions of spleen and liver. It is very helpful for rheumatic pains, Stiff joints, sprains bruises and muscular (Lawless, 1992).

There are many cultural practices for example, application of different planting dates, irrigation rates and utilizing of biofertilizer namely active dry yeast aiming to improving plant growth, yield and active substances of aromatic and medicinal plants until able to self-sufficiency to face the needs of increasing population, as well as export of these products to raising the national income. The influence of sowing dates on plant growth, yield and oil % and yield of medicinal and aromatic plants was studied by several authors such as, Zheljazkov and Topalov (1996) planted mint cuttings in 1st or 15th of Sept. and reported that planting on 1st Sep. enhanced fresh material yield. Ahmed et al (1998) showed that early sowing time increased

plant fresh and dry weight, crude and volatile oil% of *Nigella sativa.* Ahmed and Ali (2002) on fenugreek plant, applied different planting dates (Oct 30th, Nov 15th and Nov. 30th with different planting methods and they verified that there was a significant effect on fresh and dry weight / plant. They added that early sowing date led to an increase in fixed oil % as compared to other dates.

The efficiency of irrigation on growth, yield, oil % and yield of aromatic and medicinal plants was emphasized by many investigators, El-Gamasy *et al* (1973) revealed that decreasing irrigation intervals augmented leaves fresh and dry weight of sweet marjoram. They added that irrigation every at 7 days gave highest oil yield / plant than irrigation at 14 or 21 days. Rhizopoulou and Diamantoglou (1991) verified that leaves dry weight of *Origanum majorana* was increased by increasing moisture deficit. Simon *et al* (1992) reported that mild moderate plant water stress increased leaf essential oil content of sweet basil. Osman (2000) emphasized that irrigating coriander plants with high rate at (8 l/h) augmented oil % and oil yield / plant, meanwhile, the low rate (2 l/h) decreased oil yield/ plant. Ali and El-Koliey (2001) on roselle, stated that irrigation at 50% depletion recorded better results of herb dry weight. Khater *et al* (2005) on *Mentha piperta,* showed that the highest leaves and herb fresh and dry weight / plant as well as highest volatile oil yield / plant were obtained due to applying of irrigation intervals every one week comparing to other irrigation intervals (2,3 and 4 weeks). They declared that volatile oil % was increased by increasing irrigation intervals.

The positive effect of active dry yeast in enhancing plant growth, oil% and oil yield of some aromatic and medicinal plants was reported by many workers, Ahmed (1998) verified that 0.05, 0.2 and 0.4 % active dry yeast had promoting effect on herb and leaves dry weight of marjoram and the highest values of them were observed due to 0.2% yeast. The author showed that all concentrations used increased essential oil % and yield, also 0.2 % yeast gave highest values of them.

Badran *et al*, (2002) reported that active dry yeast at 1.5, 3.0 and 4.5 g/l augmented herb fresh and dry weight / plant of sweet marjoram. They indicated that 4.5 g followed by 3.0 g/l yeast produced highest values of essential oil % and oil yield / plant. They added that 4.5 g/l yeast gave highest oil yield. Abo Elazm (2008)

revealed that applying of yeast biofertilizers or phosphorein + poultry manure at $10m^3$ /fed produced highest values of herb fresh and dry weight, volatile oil % and volatile oil yield / plant of *Majorana hortensis*. Ahmed (2004) found that 4 g/l active dry yeast augmented herb fresh and dry weight of chamomile. The author added that applying active dry yeast by soil drench was better than foliar application for improving the characters. Ali *et al* (2006) stated that active dry yeast increased herb dry weight, essential oil % and essential oil yield of anise. Ali (2006) on *Foeniculum Vulgare* emphasized that essential oil % and yield were increased due to application of active dry yeast.

MATERIALS AND METHODS

A field experiment was conducted during the two successive seasons of 2003/2004 and 2004/2005 at the Experimental Farm. Fac of Agric. Al-Azhar Univ. Assiut to study the effect of sowing dates, irrigation rates, active dry yeast and their interactions on growth, essential oil percentage and essential oil yield of marjoram (*Majorana hortensis*, Moench) plants.

The marjoram seeds were obtained from Sides Horticultural Research Station, Agric. Research Center, Beni-Suef Governorate. The Seeds had been sown in the nursery beds at the following times: Sept. 27^{th} (S_1), Oct. 12^{th} (S_2), Oct. 27^{th} (S_3) and Nov. 11^{th} (S_4) of 2003/2004 and 2004/2005. The seedlings were transplanted into the Experimental Farm in the two seasons on Feb. 1^{st}, Feb. 16^{th}, Mar. 2^{nd} and Mar. 17^{th} according to the fourth planting dates of both seasons, respectively in plot which was 2.5×3.6 m^2 contained 6 rows, 60 cm apart and 25 cm between the plants.

A split split plot design with three replications, different sowing dates occupied the main plots, while irrigation rates were assigned to the sub plots and active dry yeast concentrations were considered as the sub sub plots.

In this study, the plants were irrigated by drip irrigation system with emitters 2(I_1), 4(I_2) and 6(I_3) l/h. Active dry yeast was applied through the soil at three concentrations of 0.0(Y_1), 3.0 g/l. (Y_2) and 6.0 g/l .(Y_3) three times at three week intervals starting 1^{st} April, 16^{th} April. 1^{st} May and 16^{th} May according to the fourth of planting times of both seasons, respectively.

During the growing seasons, three cuts were taken. The first cut was taken on Jun. 10th, Jun.25th, July.10th and July 25th for the fourth planting dates, respectively. The second cut, has been taken on Aug.20th, Sept.4th, Sept.19th and Oct.4th for the fourth sowing times, respectively. Meanwhile, the third cut was taken on Nov.1st, Nov,16th, Dec.1st and Dec.16th for the fourth sowing dates of both seasons, respectively. All agricultural practices were performed as usual. At each cut, the following data were recorded: herb and leaves dry weights (g). Essential oil percentage in the leaves of the three cuts were determined according to British pharmacopoeia (1963) and essential oil yield was calculated. The total dry yield of air dried herb /plant (3 cuts), total dry yield of leaves/plant (3 cuts), as well as, total essential oil yield/plant (3 cuts) were calculated. The data were statistically analyzed according to Snedecor and Corchan (1980).

RESULTS AND DISCUSSION

Vegetative growth

Herb dry weight(per cut)

Obtained data in Table (1) show that herb dry weight of marjoram plants was significantly influenced by application of planting time treatments among all cuts in the two experimental seasons. It is appear that early sowing dates produced highest herb dry weight in three cuts than late sowing ones in the two growing seasons. Moreover, maximum values of herb dry weight was detected due to applying of early sowing dates particularly in the first time of the third cut compared to other treatments among all cuts in both seasons.

Concerning irrigation rate treatments, data in Table (1) claimed that it was significant effect on herb dry weight among all cuts, except the second cut in the first season. It seems that supplying the plants with the medium rate of irrigation gave heavier herb dry weight than those obtained by other irrigation rates in three cuts of the two consecutive seasons. Moreover, application of previous rate of irrigation in the third cut yielded highest values of herb dry weight in comparison with other treatments in all cuts of the two successive seasons.

With respect to active dry yeast treatments, it was significant effect on herb dry weight among all cuts in the two experimental seasons. It is obvious that by increasing active dry yeast concentration

used herb dry weight was significantly augmented in all cuts of the two seasons. Therefore, utilizing of high concentration of yeast gave maximum herb dry weight in both seasons among the three cuts. It is concluded that treating marjoram plants with high concentration of active dry yeast in the third cut produced maximum herb dry weight in comparison with other concentrations used among the three cuts in the two growing seasons, as clearly revealed in Table(1).

Table (1): Effect of sowing date, irrigation rate and active dry yeast treatments on herb and leaves dry weight (g/plant/cut) during 2003/2004 and 2004/2005 seasons

Treatments	Herb dry weight(g/plant/cut)						Leaves dry weight (g / plant/cut)					
	First season			Second season			First season			Second season		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
S1	27.57	31.16	35.12	28.54	30.69	35.19	19.54	22.33	24.99	20.61	22.06	25.04
S2	23.80	28.32	32.29	24.02	26.18	30.67	14.78	20.46	23.13	17.59	19.03	22.01
S3	13.64	16.13	20.34	16.97	19.08	22.59	10.62	12.49	15.16	12.85	14.30	16.55
S4	10.69	13.01	17.22	12.61	14.84	18.26	8.59	10.27	12.94	9.95	11.39	13.64
L.S.D	1.97	1.00	1.23	1.69	1.66	1.87	1.07	0.51	0.70	1.09	1.09	1.09
I1	18.27	21.76	25.88	20.15	22.30	26.24	13.12	16.16	18.83	15.02	16.46	19.08
I2	19.31	22.74	26.91	21.19	23.30	27.34	13.81	16.76	19.42	15.60	17.05	19.66
I3	19.19	21.97	25.93	20.27	22.50	26.45	13.23	16.25	18.91	15.13	16.58	19.19
L.S.D	0.52	N.S	0.85	0.75	0.83	0.85	0.38	0.51	0.51	0.45	0.45	0.45
Y1	17.11	20.40	24.48	18.77	20.96	24.82	12.37	15.21	17.88	14.12	15.57	18.18
Y2	19.01	22.20	26.34	20.81	23.04	26.96	13.42	16.49	19.16	15.50	16.94	19.56
Y3	20.65	23.87	27.90	22.03	24.09	28.25	14.36	17.47	20.13	16.13	17.58	20.19
L.S.D	0.32	0.24	0.21	0.39	0.45	0.25	0.26	0.18	0.18	0.35	0.35	0.34

In regard to sowing time × irrigation rate treatments, data in Table (2) show that herb dry weight of marjoram plants significantly influenced by these treatments in both seasons, except the first and the second cuts of the first season. It is noted that applying of S_1I_3 or S_1I_2 treatments in the third cut gave higher values of herb dry weight than those of other combination treatments in all cuts of the two experimental seasons.

It is evident that the influence of sowing date × active dry yeast treatments on herb dry weight was statistically significant in the two growing seasons among all cuts, except the second cut in the

Table (2): Effect of the interaction between sowing date, irrigation rate and active dry yeast treatments on herb and leaves dry weight (g / plant/cut) during 2003/2004 and 2004/2005 seasons.

Treatments	Herb dry weight (g/ plant/cut)						Leaves dry weight (g / plant/cut)					
	First season			Second season			First season			Second season		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
S1 I1	27.10	29.96	33.96	27.54	29.60	34.18	19.73	21.55	24.22	19.94	21.39	24.37
S1 I2	28.01	31.72	35.61	28.86	30.98	35.45	20.34	22.66	25.32	20.79	22.23	25.21
S1 I3	27.61	31.79	35.79	29.22	31.48	35.95	18.56	22.77	25.44	21.12	22.56	25.54
S2 I1	23.05	27.86	31.86	22.74	25.09	29.56	14.28	20.16	22.82	16.86	18.30	21.28
S2 I2	23.86	28.52	32.42	25.05	26.99	31.85	14.82	20.59	23.26	18.13	19.58	22.56
S2 I3	24.48	28.59	32.59	24.28	26.45	30.61	15.23	20.64	23.31	17.77	19.22	22.20
S3 I1	13.21	16.61	21.01	18.30	20.31	23.68	10.39	12.95	15.62	13.68	15.12	17.37
S3 I2	14.46	17.12	21.44	17.52	19.69	23.06	11.22	13.05	15.72	13.26	14.71	16.96
S3 I3	13.24	14.66	18.57	15.07	17.23	21.03	10.26	11.48	14.14	11.62	13.07	15.32
S4 I1	9.73	12.61	16.71	12.02	14.19	17.56	8.07	9.99	12.65	9.59	11.04	13.29
S4 I2	10.92	13.58	18.17	13.32	15.52	19.01	8.86	10.73	13.39	10.23	11.68	13.92
S4 I3	11.43	12.83	16.78	12.50	14.83	18.20	8.85	10.10	12.77	10.02	11.47	13.71
$L.S.D_{0.05}$	N.S	N.S	1.69	1.51	1.65	1.71	0.76	1.01	1.01	0.89	0.90	0.90
S1 Y1	25.27	29.67	33.67	26.89	28.96	33.53	18.62	21.36	24.03	19.51	20.95	23.93
S1 Y2	27.79	31.25	35.21	28.78	31.04	35.51	19.57	22.39	25.06	20.82	22.27	25.25
S1 Y3	29.67	32.54	36.48	29.94	32.07	36.54	20.44	23.23	25.90	21.51	22.96	25.94
S2 Y1	22.25	26.63	30.63	22.58	24.94	29.09	13.75	19.34	22.00	16.76	18.20	21.18
S2 Y2	23.86	28.32	32.32	24.11	26.28	30.75	14.82	20.46	23.13	17.66	19.10	22.08
S2 Y3	25.27	30.01	33.91	25.37	27.32	32.17	15.76	21.59	24.25	18.34	19.79	22.77
S3 Y1	11.57	13.90	18.17	14.42	16.59	19.96	9.30	11.00	13.66	11.19	12.64	14.89
S3 Y2	13.66	16.07	20.47	17.60	19.77	23.14	10.54	12.62	15.29	13.31	14.76	17.00
S3 Y3	15.68	18.42	22.38	18.88	20.89	24.68	12.03	13.86	16.53	14.06	15.51	17.75
S4 Y1	9.36	11.40	15.46	11.17	13.34	16.71	7.82	9.14	11.81	9.03	10.47	12.72
S4 Y2	10.75	13.13	17.36	12.76	15.09	18.46	8.75	10.48	13.15	10.19	11.64	13.89
S4 Y3	11.98	14.49	18.85	13.91	16.10	19.60	9.22	11.19	13.86	10.62	12.07	14.32
$L.S.D_{0.05}$	0.64	0.49	0.41	0.78	N.S	0.50	0.52	0.36	0.36	N.S	N.S	N.S
I1 Y1	16.46	20.02	24.14	18.47	20.69	24.69	11.95	15.04	17.71	13.98	15.43	18.04
I1 Y2	18.29	21.68	25.87	20.37	22.54	26.46	13.11	16.14	18.81	15.16	16.61	19.22
I1 Y3	20.07	23.58	27.65	21.61	23.66	27.58	14.29	17.30	19.97	15.91	17.35	19.97
I2 Y1	17.74	21.10	25.27	19.25	21.42	25.34	12.82	15.64	18.31	14.42	15.86	18.48
I2 Y2	19.27	22.74	27.02	21.54	23.71	27.63	13.76	16.87	19.54	15.94	17.39	20.00
I2 Y3	20.93	24.37	28.44	22.78	24.76	29.06	14.85	17.76	20.42	16.45	17.90	20.51
I3 Y1	17.14	20.08	24.04	18.58	20.75	24.43	12.34	14.94	17.61	13.97	15.41	18.03
I3 Y2	19.48	22.18	26.13	20.53	22.88	26.80	13.39	16.46	19.12	15.39	16.84	19.45
I3 Y3	20.95	23.65	27.62	21.69	23.86	28.10	13.95	17.34	20.01	16.04	17.49	20.10
$L.S.D_{0.05}$	N.S	N.S	N.S	N.S	N.S	0.43	N.S	N.S	N.S	N.S	N.S	N.S

second season. It was found that heaviest weights of herb dry were observed due to application of S_1Y_3 followed by S_1Y_2 treatments in the third cut of the two consecutive seasons compared to other combination ones in the three cuts, as clearly illustrated in Table (2).

It worthy that the interactions between irrigation rate and active dry yeast treatments on herb dry weight of marjoram plants had significant effect in the third cut of the second season only. The highest values of herb dry weights were obtained due to supplying marjoram plants with I_2Y_3 followed by I_3Y_3 treatments in the third cut comparing to other combination ones, as shown in Table (2).

The interacting effect between sowing date× irrigation rate × active dry yeast treatments on herb dry weight had significant influence in the first cut of the first season only. It is appear that the most effective treatments concerning herb dry weight were $S_1I_3Y_3$ followed by $S_1I_2Y_3$ in comparison with other combination treatments, as clearly indicated in Table (3).

Leaves dry weight (per cut)

Data presented in Table (1) indicate that leaves dry weight was significantly influenced by planting date treatments among the three cuts in both seasons. Early sowing dates produced maximum values of leaves dry weight in all cuts. Moreover, in the third cut of this time gave heavier leaves dry weight than those of other cuts and other different planting dates in the two seasons.

Irrigation rate treatments significantly affected leaves dry weight in all cuts of the two growing seasons. Supplying marjoram with the medium rate of irrigation yielded heaviest weight of leaves dry among all cuts in the two seasons. The same treatment in the third cut produced highest leaves dry weight compared to other treatments in all cuts for the two consecutive seasons, as clearly shown in Table (1).

Leaves dry weight of marjoram plants was significantly affected by active dry yeast treatments in all cuts of both seasons. The high percentage of yeast in all cuts gave maximum weight of leaves dry. Moreover, treating the plants with this above concentration in the third cut yielded highest leaves dry weight comparing to other treatments among all cuts in the two successive seasons, as illustrated in Table (1).

The interaction between sowing time× irrigation rate was significantly effective on leaves dry weight among all cuts in the two experimental seasons. It is obvious that applying of S_1I_3 or S_1I_2

Table (3): Effect of the interaction between sowing date, irrigation rate and active dry yeast treatments on herb dry weight (g / plant/cut) during 2003/2004 and 2004/2005 seasons

Treatments	Herb dry weight (g / plant/cut)						Leaves dry weight (g / plant/cut)					
	First season			Second season			First season			Second season		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
S1 I1 Y1	24.94	28.57	32.57	25.97	27.82	32.61	18.47	20.63	23.30	18.89	20.34	23.32
S1 I1 Y2	27.49	29.77	33.77	27.82	29.99	34.46	19.90	21.43	24.10	20.13	21.57	24.55
S1 I1 Y3	28.87	31.53	35.53	28.83	31.00	35.47	20.83	22.60	25.27	20.80	22.25	25.23
S1 I2 Y1	26.51	30.52	34.52	26.96	29.13	33.60	19.57	21.92	24.59	19.55	21.00	23.98
S1 I2 Y2	28.09	31.70	35.57	29.28	31.45	35.92	20.31	22.63	25.29	21.10	22.55	25.53
S1 I2 Y3	29.41	32.96	36.76	30.33	32.36	36.83	21.14	23.42	26.08	21.71	23.15	26.13
S1 I3 Y1	24.35	29.92	33.92	27.75	29.92	34.39	17.81	21.53	24.19	20.08	21.53	24.51
S1 I3 Y2	27.79	32.29	36.29	29.25	31.67	36.14	18.50	23.11	25.78	21.24	22.69	25.67
S1 I3 Y3	30.69	33.15	37.15	30.67	32.84	37.31	19.37	23.68	26.35	22.03	23.47	26.45
S2 I1 Y1	21.60	26.28	30.28	21.28	23.99	28.46	13.31	19.10	21.76	16.13	17.57	20.55
S2 I1 Y2	22.96	27.84	31.84	22.81	24.98	29.45	14.22	20.14	22.81	16.79	18.23	21.21
S2 I1 Y3	24.59	29.47	33.47	24.11	26.28	30.75	15.31	21.23	23.90	17.65	19.10	22.08
S2 I2 Y1	22.71	27.01	31.01	23.69	25.86	30.33	14.05	19.59	22.26	17.37	18.82	21.80
S2 I2 Y2	23.74	28.39	32.39	25.01	27.18	31.65	14.74	20.50	23.17	18.25	19.70	22.68
S2 I2 Y3	25.12	30.15	33.85	26.45	27.94	33.58	15.66	21.68	24.34	18.76	20.21	23.19
S2 I3 Y1	22.44	26.61	30.61	22.78	24.95	28.48	13.87	19.32	21.98	16.77	18.21	21.19
S2 I3 Y2	24.89	28.75	32.75	24.52	26.69	31.16	15.51	20.74	23.41	17.93	19.38	22.36
S2 I3 Y3	26.11	30.41	34.41	25.55	27.72	32.19	16.32	21.86	24.52	18.61	20.06	23.04
S3 I1 Y1	10.99	14.05	18.50	15.68	17.85	21.22	8.91	11.40	14.07	12.04	13.48	15.73
S3 I1 Y2	13.16	16.55	21.32	18.96	21.13	24.50	10.36	13.06	15.73	14.22	15.67	17.92
S3 I1 Y3	15.49	19.22	23.22	20.26	21.96	25.33	11.90	14.39	17.06	14.77	16.22	18.46
S3 I2 Y1	12.22	14.79	19.15	14.62	16.79	20.16	9.73	11.44	14.11	11.33	12.77	15.02
S3 I2 Y2	14.33	17.12	21.72	18.05	20.22	23.59	11.13	13.15	15.82	13.61	15.06	17.31
S3 I2 Y3	16.82	19.46	23.46	19.91	22.08	25.45	12.80	14.55	17.22	14.85	16.30	18.55
S3 I3 Y1	11.51	12.86	16.86	12.96	15.13	18.50	9.25	10.15	12.82	10.22	11.67	13.91
S3 I3 Y2	13.48	14.55	18.38	15.77	17.94	21.31	10.12	11.65	14.31	12.09	13.54	15.79
S3 I3 Y3	14.73	16.57	20.46	16.47	18.63	23.28	11.40	12.63	15.30	12.55	14.00	16.25
S4 I1 Y1	8.30	11.19	15.19	10.93	13.10	16.47	7.12	9.04	11.71	8.87	10.31	12.56
S4 I1 Y2	9.56	12.53	16.53	11.90	14.07	17.44	7.96	9.94	12.60	9.51	10.96	13.21
S4 I1 Y3	11.32	14.11	18.39	13.23	15.40	18.77	9.13	10.98	13.65	10.40	11.85	14.09
S4 I2 Y1	9.52	12.07	16.40	11.75	13.92	17.29	7.93	9.62	12.29	9.41	10.86	13.11
S4 I2 Y2	10.91	13.75	18.42	13.81	15.98	19.35	8.85	11.19	13.86	10.78	12.23	14.48
S4 I2 Y3	12.33	14.92	19.70	14.42	16.65	20.38	9.80	11.37	14.03	10.49	11.94	14.19
S4 I3 Y1	10.25	10.93	14.78	10.83	13.00	16.37	8.41	8.76	11.43	8.80	10.25	12.49
S4 I3 Y2	11.78	13.11	17.11	12.58	15.23	18.60	9.43	10.32	12.99	10.28	11.73	13.98
S4 I3 Y3	12.28	14.45	18.45	14.08	16.25	19.63	8.72	11.21	13.88	10.97	12.42	14.66
L.S.D 0.05	1.11	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

treatments in the third cut produced heaviest dry weight of leaves in comparison with other combination treatments of all cuts in the two seasons, as declared in Table (2).

Data listed in Table (2) reveal that planting time × active dry yeast treatments was significantly affected leaves dry weight in the three cuts of the first season only. It seems that heaviest dry weight of leaves was recorded due to applying of S_1Y_3 followed by S_1Y_2 treatments in the third cut as compared to other combination ones in all cuts.

The combination between irrigation rate and active dry yeast treatments on leaves dry weight had no significant effect among all cuts in the two experimental seasons, as shown in Table (2).

The data illustrated in Table (3) pointed out that the interactions between sowing date × irrigation rate × active dry yeast treatments on leaves dry weight was not significant effect in the three cuts for the two seasons.

Total herb dry yield / plant (3 cuts)

Obtained data in Table (4) show that planting time treatments significantly affected on total herb dry yield / plant in the two experimental seasons. It is obvious that cultivating marjoram plants in the earliest dates produced heaviest total herb dry weights per plant compared to other late sowing dates in both seasons.

As for irrigation rate treatments, it was significant effect on total herb dry yield / plant in the two seasons. It is clear that supplying the plants with the medium rate of irrigation led to obtain a maximum value of total herb dry yield per plant in comparison with the low or the high rate of irrigation in the two growing seasons, as clearly shown in Table (4).

The main effect of active dry yeast on total herb dry yield / plant was statistically significant in the two successive seasons. The data reveal that by increasing the concentrations used of active dry yeast total herb dry yield was significantly augmented in both seasons. Therefore, it could be concluded that treating marjoram plants with the high concentration of yeast gave highest total herb dry yield / plant in the two consecutive seasons, as shown in Table (4).

Concerning sowing date × irrigation rate treatments, data in Table (5) pointed out that total herb dry yield / plant was significantly influenced by these treatments in the two experimental seasons.

Application of S_1I_2 or S_1I_3 produced highest values of total herb dry yield / plant in the two seasons as compared to other combination treatments.

According to sowing date × active dry yeast treatments, data in Table (5) indicate that it was significant effect on total herb dry yield per plant in both seasons. It is appear that S_1Y_3 followed by S_1Y_2 treatments resulted maximum values of total herb dry yield / plant comparing to other combination treatments in the two seasons. Similar trends were observed in the second season.

Table (4): Effect of sowing date, irrigation rate and active dry yeast treatments on total herb and total leaves dry weight (g/plant (3 cuts)) during 2003/2004 and 2004/2005 seasons.

Treatments	Herb dry weight g/plant		leaves dry weight g/plant	
	1st season	2nd season	1st season	2nd season
S1	93.85	94.42	66.86	67.71
S2	84.41	80.87	58.37	58.63
S3	50.11	58.64	38.27	43.70
S4	40.92	45.71	31.80	34.98
L.S.D 0.05	2.51	5.10	1.61	3.28
I1	65.92	68.69	48.11	50.55
I2	68.96	71.83	49.99	52.31
I3	67.09	69.21	48.39	50.90
L.S.D 0.05	1.81	2.26	1.10	1.34
Y1	61.99	64.54	45.45	47.87
Y2	67.55	70.82	49.06	51.99
Y3	72.42	74.37	51.96	53.91
L.S.D 0.05	0.45	0.90	0.44	1.04

Table (5) declare that total herb dry yield / plant was significantly affected by irrigation rate × active dry yeast treatments in the first season only. The heaviest total herb dry yield were obtained due to adding I_2Y_3 followed by I_3Y_3 treatments compared to other combination ones.

The interaction between sowing date× irrigation rate × active dry yeast treatments on total =]followed by $S_1I_2Y_3$ treatments recorded the most effective treatments of total herb dry yield in comparison with other combination treatments, as illustrated in Table (6).

Total leaves dry yield / plant (3 cuts)

Data presented in Table (4) reveal that total leaves dry yield / plant was significantly affected by sowing date treatments in the two experimental seasons. The heaviest total leaves dry yield were detected due to marjoram plants were sown on the earliest dates as compared to the late ones in both seasons.

It worthy that irrigation rate treatments significantly influenced on total leaves dry yield per plant in the two successive seasons. Supplying the plants with the medium rate of irrigation gave more total leaves dry yield than those obtained by the low or the high rates of irrigation in the two experimental seasons, as clearly indicated in Table (4).

Regarding to active dry yeast treatments, data in Table (4) show that total leaves dry yield per plant was significantly affected by these treatments in the two seasons. It is clear that total leaves dry yield was significantly increased by increasing active dry yeast concentration applied in both seasons. Therefore, maximum values of total leaves dry yield were obtained from treating marjoram plants with high concentration of active dry yeast.

As for planting time × irrigation rate treatments, it was significant affect on total leaves dry yield / plant in the two growing seasons.

It seems that treatments of S_1I_2 followed by S_1I_1 in the first season and S_1I_3 or S_1I_2 in the second one resulted highest values of total leaves dry yield / plant comparing to other combination treatments in the two growing seasons, as illustrated in Table (5).

The combined effect between sowing date and active dry yeast on total leaves dry yield per plant had significant effect in the first season only. The obtained results show that application of S_1Y_3 followed by S_1Y_2 produced heaviest total dry yield of leaves compared to other treatments in the two consecutive seasons as emphasized in Table (5).

Concerning irrigation rate× active dry yeast treatments, data in Table (5) pointed out that it was not significant effect on total leaves dry yield per plant in the two seasons.

Also, the interactions between planting date × irrigation rate × active dry yeast on total leaves dry yield per plant had no significant effect in the two experimental seasons, as clearly reveal in Table (6).

Table (5): Effect of the interaction between sowing date, irrigation rate and active dry yeast treatments on total herb and total leaves dry weight (g/plant (3cuts)) during 2003/2004 and 2004/2005 seasons.

Treatments	Herb dry weight (3cuts)g/plant		leaves dry weight (3cuts)g/plant	
	1st season	2nd season	1st season	2nd season
S1 I1	91.01	91.32	65.50	65.69
S1 I2	95.35	95.29	68.32	68.23
S1 I3	95.18	96.64	66.77	69.22
S2 I1	82.78	77.38	57.26	56.44
S2 I2	84.79	83.90	58.66	60.26
S2 I3	85.66	81.35	59.18	59.18
S3 I1	50.83	62.30	38.96	46.17
S3 I2	53.03	60.28	39.98	44.93
S3 I3	46.46	53.33	35.87	40.01
S4 I1	39.04	43.77	30.71	33.92
S4 I2	42.67	47.85	32.99	35.83
S4 I3	41.04	45.52	31.72	35.19
$LSD_{0.05}$	3.63	4.52	2.21	2.68
S1 Y1	88.61	89.38	64.01	64.39
S1 Y2	94.25	95.32	67.01	68.34
S1 Y3	98.69	98.55	69.57	70.40
S2 Y1	79.52	76.61	55.08	56.14
S2 Y2	84.51	81.15	58.41	58.84
S2 Y3	89.20	84.86	61.60	60.90
S3 Y1	43.64	50.97	33.96	38.72
S3 Y2	50.20	60.50	38.44	45.07
S3 Y3	56.48	64.45	42.42	47.32
S4 Y1	36.21	41.22	28.77	32.22
S4 Y2	41.24	46.31	32.38	35.72
S4 Y3	45.32	49.61	34.26	37.00
$LSD_{0.05}$	0.89	1.79	0.88	N.S
I1 Y1	60.62	63.85	44.70	47.45
I1 Y2	65.84	69.38	48.06	50.99
I1 Y3	71.30	72.85	51.56	53.22
I2 Y1	64.11	66.02	46.78	48.75
I2 Y2	69.03	72.87	50.16	53.32
I2 Y3	73.74	76.60	53.02	54.87
I3 Y1	61.26	63.76	44.89	47.40
I3 Y2	67.79	70.21	48.97	51.67
I3 Y3	72.22	73.66	51.31	53.63
$L.S.D_{0.05}$	0.77	N.S	N.S	N.S

Table (6): Effect of the interaction between sowing date, irrigation rate and active dry yeast treatments on total herb dry weight (g/plant(3cuts)) and total leaves dry weight during 2003/2004 and 2004/2005 seasons.

Treatments	Herb dry weight (3cuts)g/plant		leaves dry weight (3cuts)g/plant	
	1st season	2nd season	1st season	2nd season
S1 I1 Y1	86.09	86.40	62.40	62.54
S1 I1 Y2	91.03	92.27	65.43	66.25
S1 I1 Y3	95.92	95.29	68.68	68.26
S1 I2 Y1	91.54	89.68	66.08	64.52
S1 I2 Y2	95.36	96.65	68.23	69.17
S1 I2 Y3	99.16	99.53	70.64	71.00
S1 I3 Y1	88.19	92.06	63.54	66.11
S1 I3 Y2	96.37	97.05	67.39	69.60
S1 I3 Y3	100.98	100.82	69.39	71.95
S2 I1 Y1	78.15	73.74	54.17	54.26
S2 I1 Y2	82.64	77.25	57.16	56.24
S2 I1 Y3	87.53	81.15	60.43	58.84
S2 I2 Y1	80.74	79.89	55.90	58.00
S2 I2 Y2	84.51	83.83	58.42	60.62
S2 I2 Y3	89.12	87.97	61.68	62.16
S2 I3 Y1	79.66	76.21	55.18	56.65
S2 I3 Y2	86.38	82.37	59.66	59.65
S2 I3 Y3	90.94	85.46	62.70	61.71
S3 I1 Y1	43.54	54.76	34.37	41.25
S3 I1 Y2	51.04	64.60	39.15	47.81
S3 I1 Y3	57.92	67.55	43.35	49.45
S3 I2 Y1	46.16	51.56	35.27	39.11
S3 I2 Y2	53.17	61.86	40.10	45.98
S3 I2 Y3	59.75	67.43	44.57	49.69
S3 I3 Y1	41.22	46.59	32.22	35.80
S3 I3 Y2	46.40	55.03	36.07	41.43
S3 I3 Y3	51.76	58.38	39.32	42.80
S4 I1 Y1	34.69	40.50	27.87	31.74
S4 I1 Y2	38.63	43.41	30.49	33.68
S4 I1 Y3	43.82	47.40	33.76	36.34
S4 I2 Y1	37.99	42.96	29.85	33.38
S4 I2 Y2	43.08	49.13	33.91	37.49
S4 I2 Y3	46.95	51.45	35.20	36.63
S4 I3 Y1	35.95	40.19	28.61	31.53
S4 I3 Y2	42.00	46.40	32.74	35.99
S4 I3 Y3	45.18	49.97	33.81	38.05
L.S.D 0.05	1.54	N.S	N.S	N.S

Chemical Constituents

Essential oil percentage (per cut)

Data illustrated in Table (7) show that essential oil percentage of marjoram leaves was significantly affected by different sowing date treatments in the two successive seasons. It is clear that the second sowing date and / or the first sowing one gave more oil % than those obtained by other late sowing dates in all cuts for the two seasons. Moreover, the highest essential oil% was detected due to cultivating the plants at the second sowing date for the second cut in comparison with the first and the third cuts in both seasons.

With respect to irrigation rate, data in Table (7) pointed out that these treatments significantly influenced essential oil % in the second cut of the first season only. Supplying marjoram plants with the medium rate of irrigation gave maximum essential oil % in the second cut compared to the low or the high irrigation rates in both seasons.

The influence of active dry yeast on essential oil % of marjoram leaves was statistically significant in the two growing seasons among all cuts.

Table (7): Effect of sowing date, irrigation rate and active dry yeast treatments on essential oil percentage during 2003/2004 and 2004/2005 seasons.

Treatments	Essential oil percentage					
	First season			Second season		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
S1	1.483	1.619	1.455	1.464	1.494	1.463
S2	1.545	1.649	1.466	1.515	1.518	1.494
S3	1.430	1.548	1.439	1.471	1.484	1.453
S4	1.394	1.540	1.423	1.449	1.475	1.449
L.S.D 0.05	0.080	0.050	0.020	0.040	0.020	0.020
I1	1.448	1.550	1.453	1.473	1.491	1.457
I2	1.474	1.625	1.444	1.474	1.507	1.471
I3	1.467	1.591	1.441	1.478	1.481	1.467
L.S.D 0.05	N.S	0.030	N.S	N.S	N.S	N.S
Y1	1.406	1.501	1.404	1.434	1.452	1.424
Y2	1.468	1.591	1.447	1.470	1.492	1.465
Y3	1.515	1.674	1.486	1.520	1.534	1.505
L.S.D 0.05	0.010	0.020	0.020	0.010	0.002	0.010

Table (8): Effect of the interaction between sowing date, irrigation rate and active dry yeast treatments on essential oil percentage during 2003/2004 and 2004/2005 seasons.

Treatments	Essential oil percentage					
	First season			Second season		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
S1 I1	1.496	1.621	1.468	1.446	1.473	1.447
S1 I2	1.474	1.632	1.446	1.486	1.523	1.451
S1 I3	1.479	1.602	1.452	1.460	1.486	1.491
S2 I1	1.547	1.633	1.469	1.491	1.529	1.478
S2 I2	1.588	1.669	1.462	1.512	1.524	1.527
S2 I3	1.500	1.644	1.468	1.541	1.500	1.479
S3 I1	1.371	1.486	1.446	1.441	1.480	1.438
S3 I2	1.438	1.558	1.433	1.500	1.508	1.450
S3 I3	1.481	1.600	1.438	1.473	1.463	1.470
S4 I1	1.311	1.461	1.429	1.454	1.480	1.464
S4 I2	1.463	1.460	1.436	1.456	1.472	1.454
S4 I3	1.407	1.518	1.406	1.438	1.473	1.427
$L.S.D_{0.05}$	0.050	0.054	N.S	0.030	N.S	0.040
S1 Y1	1.422	1.526	1.426	1.417	1.454	1.420
S1 Y2	1.490	1.626	1.450	1.457	1.492	1.460
S1 Y3	1.537	1.704	1.490	1.518	1.536	1.509
S2 Y1	1.491	1.563	1.424	1.480	1.478	1.449
S2 Y2	1.550	1.653	1.458	1.502	1.516	1.492
S2 Y3	1.593	1.730	1.517	1.556	1.560	1.542
S3 Y1	1.374	1.449	1.393	1.441	1.437	1.416
S3 Y2	1.432	1.556	1.443	1.467	1.486	1.450
S3 Y3	1.483	1.639	1.480	1.502	1.529	1.492
S4 Y1	1.334	1.467	1.374	1.400	1.439	1.411
S4 Y2	1.411	1.530	1.437	1.449	1.476	1.476
S4 Y3	1.446	1.622	1.459	1.499	1.511	1.476
$L.S.D_{0.05}$	N.S	N.S	N.S	N.S	0.010	N.S
I1 Y1	1.390	1.448	1.416	1.438	1.453	1.418
I1 Y2	1.453	1.543	1.458	1.470	1.490	1.456
I1 Y3	1.500	1.660	1.485	1.510	1.529	1.497
I2 Y1	1.411	1.549	1.398	1.429	1.469	1.428
I2 Y2	1.482	1.634	1.449	1.471	1.505	1.472
I2 Y3	1.530	1.691	1.494	1.521	1.547	1.512
I3 Y1	1.416	1.506	1.408	1.436	1.434	1.426
I3 Y2	1.470	1.597	1.434	1.470	1.482	1.468
I3 Y3	1.514	1.671	1.480	1.528	1.526	1.506
$L.S.D_{0.05}$	N.S	0.030	N.S	N.S	0.010	N.S

Treating the plants with high concentration of yeast recorded highest values of oil % in all cuts during both seasons. Moreover, this concentration in the second cut resulted more essential oil % than those obtained by other concentrations used in other all cuts of the two experimental seasons, as clearly shown in Table (7).

In regard to planting date × irrigation rate, data in Table (8) declare that essential oil % significantly affected by these treatments in all cuts, except the third and second cuts in the two seasons, respectively. Application of S_2I_2 or S_2I_1 treatments gave highest values of oil % in the second cut comparing to other combinations. Meanwhile, S_2I_3 or S_2I_2 in the first cut of the second season recorded similar results.

Data recorded in Table (8) show that the combined effect between sowing time × active dry yeast on essential oil % was significant in the second cut of the second season only. The most effective treatments were S_2Y_3 followed by S_1Y_3 in comparison with other combination ones.

Data listed in Table (8) pointed out that essential oil % of marjoram leaves was significantly influenced by irrigation rate and active dry yeast in the second cut for both seasons. The best results of oil % were obtained when adding I_2Y_3 followed by I_1Y_3 treatments in comparison with other combination treatments.

The interactions between the three factors on essential oil % of marjoram leaves had significant effect in the first cut of the first season only. Application of $S_2I_2Y_3$ followed by $S_2I_2Y_2$ recorded maximum values of oil % in comparison with other combination treatments, as clearly reveal in Table (9).

Essential oil yield (per cut)

Data illustrated in Table (10) show that planting time significantly affected essential oil yield among all cuts in the two experimental seasons. It seems that early sowing dates produced high essential oil yield in all cuts of the two seasons. Moreover, the third cut with earliest planting time gave maximum values of oil yield comparing to other dates among the three cuts in the two growing seasons.

Concerning irrigation rate treatments, it was significant effect on essential oil yield in both seasons; expect the second and the third cuts of the first season. The best results of oil yield were detected due to

adding the medium rate of irrigation in the first cut and the third cut of the first and the second seasons, respectively in comparison with other rates of irrigation among all cuts, as clearly illustrated in Table (10).

It is evident that active dry yeast treatments significantly affected essential oil yield in all cuts for both seasons. It is appear that treating marjoram plants with high concentration of yeast resulted highest yield of essential oil in all cuts of the two seasons. The best results were obtained from applying high concentration of yeast in the second or the third cuts in the first season and the third cut of the second season as compared to other treatments among the three cuts, as shown in Table (10).

Essential oil yield was significantly influenced by sowing time x irrigation rates in both seasons among the three cuts, expect the second cut of the first season. Application of S_1I_2 or S_1I_1 treatments produced best results of essential oil yield in the third cut of the first season compared to other treatments. S_1I_3 or S_1I_2 treatments gave maximum values of essential oil yield in the same cut of the second season compared to other combination treatments among all cuts, as clearly illustrated in Table (11).

With respect to sowing date × active dry yeast, data in Table (11) indicate that essential oil yield was significantly affected by these treatments in both seasons, except the second cut in the first season and the first cut and the third cut of the second season. The highest essential oil yield was observed due to applying S_1Y_3 followed by S_1Y_2 treatments in the third cut and the second cut of the two experimental seasons, respectively.

The interaction between irrigation rate and active dry yeast on essential oil yield had no significant effect among the three cuts in the two growing seasons, as indicated in Table (11).

In regard to sowing date × irrigation rate × active dry yeast treatments, data in Table (12) pointed out that it was significant effect on essential oil yield in the first cut of the first season only. Application of $S_1I_1Y_3$ or $S_1I_1Y_2$ recorded the most effective treatments in comparison with other combination ones.

Table (9): Effect of the interaction between sowing date, irrigation rate and active dry yeast treatments on essential oil percentage during 2003/2004 and 2004/2005 seasons.

Treatments	Essential oil percentage					
	First season			Second season		
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
S1 I1 Y1	1.423	1.527	1.443	1.407	1.433	1.400
S1 I1 Y2	1.500	1.623	1.467	1.447	1.473	1.440
S1 I1 Y3	1.563	1.713	1.493	1.483	1.513	1.500
S1 I2 Y1	1.407	1.567	1.407	1.443	1.487	1.400
S1 I2 Y2	1.483	1.637	1.437	1.483	1.520	1.443
S1 I2 Y3	1.533	1.693	1.493	1.530	1.563	1.510
S1 I3 Y1	1.437	1.483	1.427	1.400	1.443	1.460
S1 I3 Y2	1.487	1.617	1.447	1.440	1.483	1.497
S1 I3 Y3	1.513	1.707	1.483	1.540	1.530	1.517
S2 I1 Y1	1.497	1.520	1.433	1.453	1.487	1.437
S2 I1 Y2	1.557	1.640	1.467	1.487	1.527	1.477
S2 I1 Y3	1.587	1.740	1.507	1.533	1.573	1.520
S2 I2 Y1	1.543	1.603	1.403	1.477	1.487	1.480
S2 I2 Y2	1.590	1.677	1.447	1.503	1.520	1.527
S2 I2 Y3	1.630	1.727	1.537	1.557	1.567	1.573
S2 I3 Y1	1.433	1.567	1.437	1.510	1.460	1.430
S2 I3 Y2	1.503	1.643	1.460	1.537	1.500	1.473
S2 I3 Y3	1.563	1.723	1.507	1.577	1.540	1.533
S3 I1 Y1	1.370	1.353	1.400	1.487	1.443	1.400
S3 I1 Y2	1.447	1.480	1.450	1.490	1.480	1.430
S3 I1 Y3	1.497	1.623	1.487	1.523	1.517	1.483
S3 I2 Y1	1.320	1.440	1.367	1.400	1.467	1.413
S3 I2 Y2	1.373	1.587	1.460	1.440	1.507	1.450
S3 I2 Y3	1.420	1.647	1.473	1.483	1.550	1.487
S3 I3 Y1	1.433	1.553	1.413	1.437	1.400	1.433
S3 I3 Y2	1.477	1.600	1.420	1.470	1.470	1.470
S3 I3 Y3	1.533	1.647	1.480	1.513	1.520	1.507
S4 I1 Y1	1.270	1.393	1.387	1.407	1.447	1.433
S4 I1 Y2	1.310	1.427	1.447	1.457	1.480	1.477
S4 I1 Y3	1.353	1.563	1.453	1.500	1.513	1.483
S4 I2 Y1	1.373	1.587	1.380	1.397	1.437	1.420
S4 I2 Y2	1.480	1.637	1.453	1.457	1.473	1.467
S4 I2 Y3	1.537	1.697	1.473	1.513	1.507	1.477
S4 I3 Y1	1.360	1.420	1.357	1.397	1.433	1.380
S4 I3 Y2	1.413	1.527	1.410	1.433	1.473	1.433
S4 I3 Y3	1.447	1.607	1.450	1.483	1.513	1.467
L.S.D 0.05	0.030	N.S	N.S	N.S	N.S	N.S

Total essential oil yield / plant (3 cuts)

Data presented in Table (10) show that planting date treatments significantly affected total essential oil yield / plant in the two consecutive seasons. Early sowing dates recorded maximum values of total essential oil yield compared to the late sowing ones in both seasons.

Regarding to irrigation rate treatments, it was significant effect on total essential oil yield per plant in the two successive seasons.

Supplying marjoram plants with irrigation at the medium rate produced highest total essential oil yield in comparison with low or high irrigation rates in the two growing seasons, as indicated in Table (10).

Table (10): Effect of sowing date, irrigation rate and active dry yeast treatments on essential oil yield /cut and total essential oil yield/plant during 2003/2004 and 2004/2005 seasons.

Treatments	Essential oil yield/cut and total essential oil yield /plant							
	First season				Second season			
	1st cut	2nd cut	3rd cut	ml/plant	1st cut	2nd cut	3rd cut	ml/plant
S1	0.290	0.362	0.364	1.016	0.302	0.330	0.367	0.999
S2	0.229	0.338	0.339	0.906	0.267	0.289	0.329	0.885
S3	0.152	0.194	0.219	0.565	0.190	0.213	0.241	0.643
S4	0.120	0.179	0.185	0.464	0.144	0.163	0.198	0.514
L.S.D 0.05	0.020	0.040	0.010	0.030	0.020	0.020	0.020	0.030
I1	0.193	0.270	0.275	0.723	0.221	0.246	0.278	0.747
I2	0.205	0.274	0.281	0.760	0.231	0.258	0.290	0.781
I3	0.195	0.261	0.274	0.730	0.225	0.246	0.283	0.754
L.S.D 0.05	0.010	N.S	N.S	0.020	0.010	0.010	0.010	0.010
Y1	0.176	0.230	0.252	0.658	0.203	0.227	0.259	0.690
Y2	0.199	0.265	0.278	0.741	0.228	0.253	0.287	0.769
Y3	0.219	0.310	0.300	0.814	0.246	0.270	0.305	0.822
L.S.D 0.05	0.002	0.030	0.002	0.010	0.010	0.001	0.010	0.010

It is worthy that total essential oil yield per plant of marjoram significantly influenced by active dry yeast treatments in both seasons. The best result of total oil yield / plant was recorded when treating the plants with high concentration of active dry yeast in the two seasons, as clearly shown in Table (10).

As for planting time × irrigation rate, data in Table (11) reveal that total essential oil yield per plant was significantly affected by these combination treatments in the second season only. Application of S_1I_3 or S_1I_2 produced maximum values of essential oil yield / plant compared to other combination treatments.

Table (11) show that total essential oil yield per plant was significantly affected by the treatments of sowing date and active dry yeast in the two consecutive seasons. The combinations of S_1Y_3 followed by S_1Y_2 yielded highest essential oil yield / plant in comparison with other treatments in the two seasons.

The influence of irrigation rate × active dry yeast treatments on total essential oil yield / plant had no significant in both seasons, as clearly reveal in Table (11).

Total essential oil yield per plant was not significantly affected by the interactions of planting time × irrigation rate × active dry yeast in the two seasons, as shown in Table (12).

Table (11): Effect of the interaction between sowing date, irrigation rate and active dry yeast treatments on essential oil yield/cut and total essential oil yield/plant during 2003/2004 and 2004/2005 seasons.

Treatments	Essential oil yield/cut and total essential oil yield /plant							
	First season				Second season			
	1st cut	2nd cut	3rd cut	ml/plant	1st cut	2nd cut	3rd cut	ml/plant
S1 I1	0.296	0.350	0.356	1.002	0.289	0.315	0.353	0.959
S1 I2	0.300	0.370	0.366	1.036	0.309	0.339	0.366	1.015
S1 I3	0.275	0.366	0.370	1.010	0.309	0.336	0.381	1.024
S2 I1	0.222	0.330	0.336	0.887	0.251	0.280	0.315	0.845
S2 I2	0.235	0.344	0.341	0.920	0.275	0.299	0.345	0.920
S2 I3	0.229	0.340	0.342	0.912	0.274	0.289	0.329	0.890
S3 I1	0.150	0.194	0.226	0.570	0.205	0.224	0.250	0.682
S3 I2	0.154	0.204	0.226	0.584	0.192	0.222	0.246	0.660
S3 I3	0.152	0.184	0.203	0.540	0.172	0.192	0.225	0.587
S4 I1	0.106	0.206	0.181	0.433	0.140	0.163	0.195	0.500
S4 I2	0.130	0.176	0.193	0.499	0.149	0.172	0.203	0.527
S4 I3	0.125	0.154	0.180	0.459	0.144	0.169	0.196	0.514
$L.S.D_{0.05}$	0.010	N.S	0.020	N.S	0.020	0.020	0.020	0.030
S1 Y1	0.265	0.326	0.343	0.933	0.276	0.305	0.340	0.924
S1 Y2	0.291	0.364	0.363	1.019	0.303	0.332	0.369	1.003
S1 Y3	0.314	0.396	0.386	1.096	0.327	0.353	0.391	1.071
S2 Y1	0.205	0.302	0.313	0.821	0.248	0.269	0.307	0.823
S2 Y2	0.230	0.338	0.337	0.905	0.266	0.290	0.330	0.888
S2 Y3	0.251	0.374	0.368	0.993	0.286	0.309	0.351	0.945
S3 Y1	0.128	0.159	0.190	0.477	0.162	0.182	0.211	0.556
S3 Y2	0.151	0.196	0.221	0.568	0.195	0.219	0.247	0.659
S3 Y3	0.178	0.227	0.245	0.650	0.212	0.237	0.265	0.715
S4 Y1	0.105	0.134	0.162	0.401	0.127	0.151	0.179	0.458
S4 Y2	0.123	0.161	0.189	0.473	0.148	0.172	0.203	0.525
S4 Y3	0.133	0.241	0.202	0.517	0.159	0.182	0.211	0.558
$L.S.D_{0.05}$	0.010	N.S	0.010	0.020	N.S	0.010	N.S	0.020
I1 Y1	0.169	0.222	0.252	0.642	0.201	0.224	0.265	0.683
I1 Y2	0.194	0.253	0.275	0.722	0.223	0.248	0.280	0.751
I1 Y3	0.218	0.336	0.297	0.806	0.240	0.266	0.299	0.807
I2 Y1	0.182	0.244	0.255	0.681	0.207	0.234	0.264	0.708
I2 Y2	0.205	0.276	0.283	0.764	0.235	0.262	0.295	0.792
I2 Y3	0.228	0.301	0.306	0.835	0.251	0.278	0.311	0.841
I3 Y1	0.176	0.226	0.249	0.651	0.201	0.222	0.258	0.680
I3 Y2	0.198	0.265	0.275	0.738	0.227	0.250	0.287	0.763
I3 Y3	0.212	0.292	0.297	0.801	0.247	0.267	0.304	0.819
$L.S.D_{0.05}$	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Table (12): Effect of the interaction between sowing date, irrigation rate and active dry yeast treatments on essential oil yield /cut and total essential oil yield/plant during 2003/2004 and 2004/2005 seasons.

Treatments	Essential oil yield/cut and total essential oil yield /plant							
	First season				Second season			
	1st cut	2nd cut	3rd cut	ml/plant	1st cut	2nd cut	3rd cut	ml/plant
S1 I1 Y1	0.263	0.315	0.336	0.914	0.266	0.292	0.327	0.889
S1 I1 Y2	0.298	0.348	0.353	1.000	0.291	0.318	0.353	0.963
S1 I1 Y3	0.326	0.387	0.377	1.090	0.309	0.337	0.379	1.026
S1 I2 Y1	0.275	0.343	0.346	0.964	0.282	0.312	0.336	0.931
S1 I2 Y2	0.301	0.370	0.364	1.035	0.313	0.343	0.369	1.024
S1 I2 Y3	0.324	0.397	0.380	1.110	0.332	0.362	0.394	1.089
S1 I3 Y1	0.256	0.320	0.345	0.920	0.281	0.311	0.357	0.953
S1 I3 Y2	0.275	0.373	0.373	1.021	0.306	0.337	0.384	1.023
S1 I3 Y3	0.293	0.404	0.391	1.088	0.339	0.359	0.401	1.097
S2 I1 Y1	0.200	0.291	0.312	0.802	0.234	0.261	0.295	0.790
S2 I1 Y2	0.222	0.330	0.335	0.887	0.249	0.278	0.314	0.839
S2 I1 Y3	0.243	0.370	0.360	0.973	0.270	0.301	0.336	0.907
S2 I2 Y1	0.217	0.314	0.312	0.843	0.257	0.280	0.323	0.865
S2 I2 Y2	0.234	0.344	0.335	0.913	0.274	0.300	0.346	0.925
S2 I2 Y3	0.255	0.374	0.374	1.004	0.292	0.317	0.365	0.971
S2 I3 Y1	0.199	0.302	0.316	0.818	0.253	0.266	0.303	0.813
S2 I3 Y2	0.233	0.341	0.342	0.916	0.276	0.291	0.330	0.899
S2 I3 Y3	0.255	0.377	0.369	1.001	0.294	0.309	0.353	0.959
S3 I1 Y1	0.122	0.154	0.197	0.473	0.179	0.195	0.220	0.597
S3 I1 Y2	0.150	0.193	0.228	0.572	0.212	0.232	0.256	0.704
S3 I1 Y3	0.178	0.234	0.254	0.666	0.225	0.246	0.274	0.745
S3 I2 Y1	0.129	0.164	0.192	0.486	0.158	0.187	0.213	0.562
S3 I2 Y2	0.153	0.208	0.231	0.593	0.196	0.227	0.251	0.670
S3 I2 Y3	0.181	0.240	0.254	0.675	0.221	0.253	0.275	0.749
S3 I3 Y1	0.132	0.158	0.181	0.471	0.147	0.163	0.199	0.508
S3 I3 Y2	0.150	0.168	0.203	0.539	0.178	0.199	0.232	0.603
S3 I3 Y3	0.175	0.208	0.226	0.609	0.190	0.213	0.245	0.651
S4 I1 Y1	0.090	0.126	0.162	0.378	0.125	0.149	0.180	0.454
S4 I1 Y2	0.104	0.142	0.182	0.428	0.138	0.162	0.195	0.498
S4 I1 Y3	0.123	0.172	0.198	0.493	0.156	0.179	0.209	0.549
S4 I2 Y1	0.109	0.153	0.170	0.431	0.132	0.156	0.186	0.475
S4 I2 Y2	0.131	0.183	0.201	0.515	0.157	0.180	0.212	0.551
S4 I2 Y3	0.151	0.193	0.207	0.550	0.159	0.180	0.209	0.554
S4 I3 Y1	0.115	0.124	0.155	0.394	0.123	0.147	0.172	0.444
S4 I3 Y2	0.133	0.158	0.183	0.474	0.147	0.173	0.200	0.526
S4 I3 Y3	0.126	0.180	0.201	0.507	0.163	0.188	0.215	0.571
L.S.D 0.05	0.030	N.S	N.S	N.S	N.S	N.S	N.S	N.S

DISCUSSION

From the obtained results, it could be discussed as follow: Cultivating marjoram plants in early planting time particularly the first sowing date led to an improve in herb, leaves dry weight among all cuts and total yield / plant, essential oil percentage and yield in comparison with other late sowing dates, this result may be due to the efficiency of the variations of temperatures through the different planting dates which acts an role in physiological and biochemical processes in plants which may reflect on effectiness the plant characters. In addition, better results concerning the previous parameters as a result of applying early sowing dates may be due to the favorable weather conditions during this period which may encourage the photosynthetic activity and stimulating effect on herb, leaves, essential oil% and yield. The increment of above parameters as a result of supplying the plants with the medium rate of irrigation compared to other rates applied (low or high rates) may be due to the effect of irrigation treatments which reflect the physiological and biological roles on improving these characters, as studied by many investigations. Plants rich in essential oils are much more abundant in dry than those in humid habitats, this fact has been evaluated from a view point that volatile oil plays a part in the mechanism of drought resistance by transpiration reduction (Fluck, 1955). In Certain cases, drought affects the growth due to lack of water needed for physiological and biochemical reactions (Ong 1978). Essential oil yield in aromatic plants was affected by moisture stress which is a significant environmental factor (Penka, 1978). Charles *et al.* (1990) demonstrated that essential oil accumulation in peppermint may be indirectly influenced through its effects on either net accumulation through effect on or the partitioning of assimilates among the growth and differentiation processes. The stimulating effect of active dry yeast in enhancing herb dry and leaves dry yield, essential oil percentage and yield of marjoram plants obtained in this work could be attributed to their important role. The analysis of active dry yeast shows that it contains protein, amino acids, fat and other components that its reflects on improving the aforementioned parameters. Tarrow and Nakase (1975) and Subba Rao (1984) mentioned that active dry yeast contains high amounts of four vitamins, particularly B which is positive effect in enhancing the growth and controlling the fungi diseases incidence. Also, its greater content of minerals especially N,

P and K. The increase in carbon dioxide release through the fermentation process effectively activates the photosynthesis and accelerates the carbohydrates biosynthesis (Ahmed *et al.*, 1997). It contains certain natural hormones such as cytokinins which plays an important role in physiological and biochemical process in plants that its reflect on enhancing the growth and chemical constituents (Ferguson, *et al.*, 1997). Application of active dry yeast reduced at a low extent the great use of insecticides, which caused an adverse effect on plant growth and production, whereas vitamin B plays active role in polar movement of native auxin from their synthesis site into the presumed site use in the roots (Buchala and Schmid, 1979). Yeast as biofertilizer plays a beneficial role in improving flower in the formation of flower initiation due to its effect on carbohydrates accumulation (Winkler, *et al.*,1962). It has a promoting effect on enlargement and cell division, protein and nucleic acid synthesis and chlorophyll formation (Kraing and Haber 1980., Spencer *et al.*,1983 and Eata *et al.*, 2001). Bio-fertilization have important role in plant diseases control (Camliel and Katan, 1993, Linderman, 1994 and Abdel-Latif *et al.*,2001).Furthermore, bio-fertilizers have to be low cost, eco-friendly and renewable sources of plant nutrients supplementing chemical fertilizers in sustainable agricultural systems (Galal and Ali, 2004).

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تاثير معاملات مواعيد الزراعه ومعدلات الري والخميره الجافه النشطه علي النمو والزيت الطيار لنباتات البردقوش

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اجري هذا البحث خلال موسمين متتاليين ٢٠٠٣/٢٠٠٤ ، ٢٠٠٤/٢٠٠٥ بهدف دراسه تاثير مواعيد الزراعه (٢٧ سبتمبر ، ١٢ اكتوبر ،٢٧ اكتوبر ، ١١ نوفمبر) واستخدام نظام الري بالتنقيط بمعدل ٢ ، ٤ ، ٦ لتر/ ساعة وكذلك اضافه الخميره الجافه النشطه عن طريق التربه بالتركيزات صفر ، ٣، ٦ جرام / لتر والتداخل بينهم علي وزن العشب الجاف ووزن الاوراق الجافه خلال الثلاث قرطات وكذلك علي المحصول الكلي للنبات من العشب والاوراق وايضا علي النسبه المئوية للزيت الطيار في الاوراق خلال القرطات الثلاثه وكذا علي محصول الزيت الطيار في كل حشه علي حده وايضا علي محصول النبات الكلي من الزيت الطيار لنبات البردقوش .

اوضحت النتائج المتحصل عليها الاتي :-

١- تاثير مواعيد الزراعه :-

اعطت المواعيد المبكره وخاصه الميعاد الاول اعلي وزن جاف للعشب والاوراق وكذا محصول الزيت الطيار في كل قرطة ، كما اتضح ان هذا الميعاد في القرطة الثالثه قد سجل افضل النتائج بالنسبه لهذه الصفات السابقه ، ايضا المواعيد المبكره وخاصه الميعاد الاول سجل افضل النتائج بالنسبه لمحصول النبات الكلي من العشب الجاف والاوراق والمحصول الكلي للنبات من الزيت الطيار . كذلك اعطت المواعيد المبكره وخاصه الميعاد الثاني في القرطة الثانيه افضل نسبه مئوية للزيت الطيار مقارنه بباقي القرطات .

٢- تاثير معدلات الري :-

استخدام المعدل المتوسط اعطي اعلي وزن جاف من العشب والاوراق في القرطات الثلاثه ،واعطي ايضا المعدل المتوسط في القرطة الاولي والثالثه في الموسمين علي الترتيب افضل محصول زيت طيار . وهذا المعدل المذكور في القرطة الثالثه قد سجل اعلي وزن جاف للعشب والاوراق مقارنه بباقي القرطات . اعطي المعدل المتوسط في القرطه الثانيه في الموسم الاول فقط اعلي نسبه مئويه للزيت الطيار علي الرغم ان تاثير معاملات الري غير معنوي في باقي القرطات في الموسمين. ايضا اعطي المعدل المتوسط في القرطة الاولي والثالثه في الموسمين علي الترتيب افضل محصول للزيت الطيار . كذلك سجل المعدل المتو سط اعلي محصول كلي للنبات من العشب والاوراق والزيت الطيار مقارنه بالمعدل المنخفض والعالي.

٣- تاثير الخميرة الجافه النشطه :-

استخدام التركيز العالي ادي الي الحصول علي اعلي وزن جاف من العشب والاوراق والنسبه المئوية للزيت الطيار ومحصول الزيت الطيار فى جميع القرطات. اضافة الى ان هذا التركيز في القرطة الثالثة قد انتج اعلى وزن جاف للعشب والاوراق ومحصول الزيت الطيار مقارنة بباقي المعاملات في القرطات الثلاث. بينماافضل نسبة مئوية للزيت الطيار سجلت نتيجة المعاملة بالتركيز العالى فى القرطة الثانية. ايضا استخدام التركيز العالى اعطى افضل محصول كلي للنبات من العشب والاوراق والزيت الطيار.

٤- تأثير التداخل بين مواعيد الزراعة x معدلات الري:-

سجلت البيانات أفضل وزن جاف للعشب و الاوراق عند التداخل بين الميعاد الاول × المعدل العالي أو الميعاد الاول × المعدل المتوسط وذلك في القرطة الثالثه مقارنه بباقي القرطات الثلاثة. واعطي التداخل بين الميعاد الثاني× المعدل المتوسط يليه الميعاد الثاني × المعدل المنخفض في القرطه الثانيه أكبر نسبة مئوية للزيت الطيار وذلك في الموسم الاول بينما التداخل بين الميعاد الثاني x المعدل العالي او الميعاد الثاني x المعدل المتوسط للري في القرطةالاولى قد اعطى اعلى نسبة % للزيت الطيار في الموسم الثاني واعطى الميعاد الاول x المعدل المتوسط يلية الميعاد الاول × المعدل المنخفض في القرطة الثالثة افضل محصول زيت طيار في الموسم الاول اماالتداخل بين الميعاد الاول x المعدل العالى او الميعاد الاول x المعدل المتوسط في نفس القرطة قد سجل احسن النتائج بالنسبة لمحصول الزيت الطيار في الموسم الثاني. اكبر محصول كلى من العشب الجاف نتيجه التداخل بين الميعاد الاول x المعدل العالى او الميعاد الاول x المعدل المتوسط مقارنة بباقي التداخلات.

وافضل محصول كلي للاوراق الجافه نتيجه التداخل بين الميعاد الاول × المعدل المتوسط يليه الميعاد الاول × المعدل المنخفض وذلك في الموسم الاول .

اما في الموسم الثاني فكان نتيجه التداخل بين الميعاد الاول × المعدل العالي او الميعاد الاول × المعدل المتوسط . اما عن افضل محصول كلي للنبات من الزيت الطيار نتيجه التداخل بين الميعادالاول × المعدل العالي او الميعاد الاول × المعدل المتوسط وذلك في الموسم الثاني فقط بينما تاثير التداخل غير معنوي في الموسم الاول .

٥- تاثير التداخل بين مواعيد الزراعه × الخميرة الجافه النشطة

اعطي التداخل بين الميعاد الاول × التركيز العالي يليه الميعاد الاول × التركيز المنخفض في القرطة الثالثه اكبر وزن جاف للعشب مقارنه بباقي المعاملات في القرطات الاخري . نفس النتائج بالنسبه لوزن الاوراق الجافه ومحصول الزيت الطيار وذلك في الموسم الاول فقط ، بينما التاثير لهذه المعاملات كان غير معنويا في كل القرطات في الموسم الثاني بالنسبه لوزن الاوراق ولكن نفس المعاملات السابقه ولكن في القرطة الثانيه في الموسم الثاني بالنسبه للحصول علي افضل محصول زيت طيار اعطي التداخل بين الميعاد الثاني × التركيز العالي يليه الميعاد الاول × نفس التركيز افضل نسبه مئويه للزيت الطيار وذلك في القرطة الثانيه في الموسم الثاني بينماالتاثير غير معنويا في باقي القرطات لكلا الموسمين . وايضا التداخل بين الميعاد الاول × التركيز العالي يليه الميعاد الاول × التركيز المنخفض قد سجل افضل محصول كلي للنبات من العشب الجاف والزيت الطيار .

نفس النتائج تم الحصول عليها بالنسبه لافضل محصول كلي للنبات من الاوراق الجافه من هذه المعاملات وذلك في الموسم الاول فقط بينما تاثير التداخل غير معنوي في الموسم الثاني .

٦ – تاثير التداخل بين معدلات الري × الخميره الجافه النشطه :-

اعطي التداخل بين المعدل المتوسط × التركيز العالي يليه المعدل العالي × نفس التركيز في القرطة الثالثه بالموسم الثاني اعلي وزن جاف للعشب مقارنه بباقي المعاملات اضافه الي ان التاثير غير معنوي في باقي القرطات لكلا الموسمين سجلت تلك المعاملات تاثير غير معنوي في كل القرطات في كلا الموسمين بالنسبه لوزن الاوراق الجافه ومحصول الزيت الطيار. سجلت البيانات ان استخدام المعدل المتوسط × التركيز العالي خميرة يليه المعدل المنخفض × نفس التركيز في القرطة الثانيه فقط في كلا الموسمين اعلي نسبه مئوية للزيت الطيار والتاثيرغير معنوي في باقي القرطات في الموسمين . وكذلك اعطي التداخل بين المعدل المتوسط للري × التركيز العالي خميره يليه المعدل العالي ري × التركيز العالي من الخميره في الموسم الاول اعلي محصول كلي للنبات من العشب الجاف بينما التاثير غير معنوي في الموسم الثاني . سجلت البيانات ايضا ان تاثير التداخل غيرمعنوي في كلا الموسمين علي المحصول الكلي للنبات من الاوراق الجافه والزيت الطيار .

٧- التداخل بين مواعيد الزراعه × معدلات الري × الخميرة الجافه النشطه :-

سجلت معاملات التداخل بين المعاد الاول × المعدل العالي من الري × التركيز العالي من الخميره يليه الميعاد الاول × المعدل المتوسط ري × التركيز العالي من الخميره في القرطة الاولي في الموسم الاول افضل وزن جاف للعشب بينما كان التاثير غير معنوي في باقي القرطات لكلا الموسمين .

أحسن نتائج تم الحصول عليها بالنسبة لمحصول الزيت الطيار فى القرطة الأولى للموسم الأول فقط نتيجة معاملة المعاد الأول x المعدل المنخفض من الرى x التركيز العالى من الخميرة أو الميعاد الأول x المعدل المنخفض للرى x التركيز المنخفض للخميره و وتبين أن تأثير التداخل غير معنوى فى باقى القرطات لكلا الموسمين .

ايضا تاثير التداخل علي الوزن الجاف للاوراق في جميع القرطات وكذلك المحصول الكلي للنبات لكل من الاوراق الجافه والزيت الطيار في كلا الموسمين غير معنوي . كذلك اعطي التداخل بين الميعاد الاولx المعدل العالي من الري × التركيز العالي من الخميره يليه الميعاد الاول × المعدل المتوسط للري × التركيز العالي من الخميره في الموسم الاول افضل محصول كلي للنبات من العشب الجاف بينما كان التاثير غير معنويا في الموسم الثاني. اعلي القيم من النسبه المئوية للزيت الطيار تم الحصول عليها نتيجه التداخل بين الميعاد الثاني × المعدل المتوسط للري × التركيز العالي من الخميره يليه الميعاد الثاني × المعدل المتوسط للري × التركيز المنخفض من الخميره وذلك في القرطة الاولي فقط في الموسم الاول بينما تاثير التداخل في باقي القرطات لكلا الموسمين غير معنوي .