Effect of Cold Storage of Bulbs and Bulb Weight on Growth, Flowering, Essential Oil Components and Bulb Active Ingredients of *Narcissus tazetta* Plant

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Abstract: Field experiments were carried out at the Experimental Farm of El-Kassasin Horticultural Research Station, Ismailia Governorate, Egypt, during two successive seasons (2017-2018 and 2018-2019). To evaluate the effect of cold storage periods (1, 2, 3, 4, 5-weeks at 5°C beside room temperature as control) and bulb weight (100, 150 and 200±5 g) of *Narcissus tazetta* L**.** cv. Cheerfullness bulbs on growth, flowering, bulbs production, leaf minerals content and some bulb active ingredients. The results showed positive effects of cold storage and bulb weight as well as the interaction between them on growth, flowering and bulbs production. The highest values of vegetative growth, flower quality and early flowering, bulb yield and mineral content of dry leaves were obtained by the interaction between the longest periods of cold storage (5-weeks) with the highest bulb weight (200 g). Whereas higher values of active ingredients in dry bulbs, especially antioxidant activity were recorded by the interaction between the cold storage period of two weeks with weights 150 and 100 g/bulb. These results were recorded in both seasons. All treatments gave differences in essential oil components of flowers.

Keywords: *Narcissus tazetta,* cold storage, bulb weight, growth, flowering, active ingredients, phenols, flavonoids, antioxidants activity, essential oil components

INTRODUCTION

Ornamental plants are considered one of the very promising crops in Egypt. Narcissus flower is one of the main exportable flowers and the foreign trade, demand Egyptian flowers with high quality and must match the international standers of the exportable flower. *Narcissus tazetta* L. with the common name of "Narjes" is generally easy to grow, it grows in the winter or spring and is dormant in summer, *Narcissus tazetta* L. cv. Cheerfulness' is a fragrant, late bloomer with creamy white flowers and yellow flecks.

Narcissus genus, which has as many as eighty species, is the most representative of Amaryllidaceae family (Takos and Rook, 2013). Narcissus is used as an emetic, wound healer, heart and memory intensifier, for the cure of epilepsy and leprosy diseases as well for poliomyelitis and Alzheimer treatments in folk and modern medicine (Orhan and Şener, 2003), also it has important medicinal values currently used in the extraction of alkaloids and flavonoids (Abdel-Rahman, 2017). Bulbs contain flavonoids like rutin, quercetin and kaempferol, phenolic acids (Lubbe *et al*., 2013), flavonoids particular importance, they have been found to possess antioxidant and free radical scavenging activity (Iwashina, 2000). Also, Bulbs contain a glycoprotein called lectin (Ooi *et al*., 2000). *Narcissus tazetta* lectin shows strong inhibitory effects against the respiratory syncytial virus, influenza A (H_1N_1, H_3N_2, H_5N_1) and B viruses (Ooi *et al*., 2010). Bulb alkaloids have been identified including the antitumor agent narciclasine and galanthamine, *Narcissus* is one of the oldest known plants in the perfume industry (Remy, 2002). Moreover, *Narcissus* is critically important for the world trade of cut flowers and bulbs.

Many factors including genotype, location, ecological factors and growth techniques affect the flowers, bulb quality and bulb yield of *Narcissus* (Nazki *et al*., 2005, Özel and Erden, 2018). In addition, the bulb yield is changed dependent on the bulb weight and bulb densities (Khan *et al.,* 2013). Small bulbs do not give flowers or result in products with low market potential (Rees, 1986). Hanks (2002) and Özel and Erden (2018) reported that *Narcissus* yields are mainly controlled by the grade of bulbs. For this reason, it is important to determine the bulb weight for optimum yield and appropriateness for cut flower and landscape areas.

The storage temperature is a paramount factor that affects the physiological behavior and morphological traits of *Narcissus*, low temperature period is very important to increasing *Narcissus* flower production and quality. Increasing cold storage periods of bulbs led to improving growth, flowering quantity and quality, as reported by Toama *et al.* (2008) and Noy *et al.* (2010) on *Narcissus tazetta*, Gomaa (2000) on tuberose, Soliman (2002) on *Iris tingitana*, El-Bably (2003) on *Antholyza aethiopica*, El-Bably and Mahmoud (2005) on *Tritonia crocata* and Thompson *et al.* (2011) on *Lachenalia*.

Plant height, inflorescence length, and the number of florets, which are all very important quality features, increased with increasing bulb weight at planting. Bulb yield was increased as the main bulb weight increased. In most cases, flower yield was dependent on bulb weight and earlier inflorescence. In general, inflorescence was improved with increased bulb weight as indicated Özel and Erden (2018) on *Narcissus tazetta*, Addai and Scott (2011) on hyacinth and the lily**,** Thompson *et al.* (2011) and Kapczyńska (2014) on *Lachenalia* regarding the effect of bulb weight on growth and flowering.

This work was performed to investigate the effect of cold storage periods of bulbs and bulb weight on

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growth, flowering, and essential oil components of flowers, bulbs production and some bulb active ingredients of *Narcissus tazetta* L. cv. Cheerfulness Plant.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm of El-Kassasin Horticultural Research Station, Ismailia Governorate, Egypt, during two successive seasons 2017-2018 and 2018-2019. *Narcissus tazetta* bulbs were obtained from Harraz Company, Cairo, Egypt. The bulbs were divided into three weights of 200±5, 150±5 and 100±5 g, then they were stored at 5°C for 1, 2, 3, 4 and 5-weeks in the refrigerator before planting in addition to control treatment (storage at room temperature of 28±3°C), bulbs were sown in 28th October in both seasons with coated 15 cm soil. The soil of the experimental field was sandy in texture and its physical and chemical properties are shown in Table (1). Samples of the soil were obtained from 25 cm soil surface were conducted according to Page *et al.* (1982) and Klute (1986).

Table (1): Physical and chemical properties of the experimental soil

Physical properties						
Coarse sand %	**Fine sand %**	**Silt %**	**Clay %**	**$CaCo_3$ %**	**O.M %**	**Soil texture**
5.08	78.51	10.38	6.03	1.20	0.83	Sandy

Chemical properties										
pH	**EC dS/m**	**Ion concentration (Mmol/l)**						**Available nutrients (mg/kg)**		
		Ca^{++}	**Mg^{++}**	**Na^{+}**	**K^{+}**	**CO^{-3}**	**So^{-4}**	**N**	**P**	**K**
8.0	0.81	3.60	2.70	1.75	0.55	0.03	3.15	52.60	9.10	100.51

The experiment included 18 treatments were the combination between three bulb weights (200, 150 and 100 g) treatments and six cold storage treatments (control, 1, 2, 3, 4 and 5-weeks before sowing). The treatments were arranged in a split plot design with three replicates, cold storage treatments were distributed randomly in the main plots, while sub-plots were devoted to the bulb weights.

The experimental unit area was 16.8 m^2 (4.2 x 4 m) and each unit contained six rows with 4 m length for each and 70 cm width of them. The distance between bulbs was 25 cm within a row; the four middle rows were used for inflorescences and bulbs yield determination, whereas the two outer rows were used for the determination of plant growth characters. The normal agricultural practices under the drip irrigation system were followed.

Data recorded:

Growth: Sprout date (days): date on which 70% appearance of plants occurred at each plot was recorded as sprout date. At flowering stage, leaf length (cm), number of leaves/plant and fresh and dry weights of leaves/plant (g) were recorded.

Flowering: Flowering date (Number of days from planting to the first flower showing colour), flowering period (the period from starting of flowering to the end was determined for randomly selected 20 plants at each plot and their average was recorded)including spike and rachis length (cm) florets number/spike, spike fresh weight (g), diameter of floret (mm), vase-life (days). Vase-life (days) was determined by choosing three similar stalks from each replicate at the stage of opening of the first floret and put in a vase containing distilled water.

Bulbs yield components: At the end of the experiment, on the third week of April for both seasons, the bulbs and bulbils were carefully collected of the soil, air-dried and the following data were recorded: diameter of the main bulb (mm), fresh weight of main bulb (g) and the number of bulbils/plant.

Chemical contents of dry leaves: N, P and K (mg/g dry weight) of the fourth inner leaf at the flowering stage were determined according to AOAC (2005).

Some active ingredients and antioxidant activity in the dry bulb: Both total phenols (mg/100 g), total flavonoids (mg/100g) and antioxidant activity (as DPPH radical–scavenging activity, %) of dry bulbs were determined as described by Youssef and Mokhtar (2014).

Extraction and Gas chromatography analysis of the essential oil: In the second season, the essential oil was extracted from the fresh flowers by ethyl ether solvent. The Gas chromatography (GC) analysis of the essential oil samples was carried out in the Laboratory of Medicinal and Aromatic Plants Research Department, Horticulture Research Institute, ARC using Ds Chrom 6200 Gas Chromatograph apparatus, fitted with a capillary column BPX-5, 5 phenyl (equiv.) polysillphenylene-siloxane 30 x 0.25 mm ID x 0.25µ film. The temperature program varied in the range 70-200°C, at a rate of 10°C/min. Flow rates of gases were nitrogen at 1 ml/min, hydrogen at 30 ml/min and 330 ml/min for air. Detector and injector temperatures were 300°C and 250°C respectively. The identification of the compounds was done by matching their retention times with those of authentic samples injected under the same conditions.

Statistical analyses:

All obtained data were statistically analyzed according to the analysis of variance (ANOVA) for the split plot design as published by Gomez and Gomez (1984) by using "MSTAT-C" computer software package. Least Significant Difference (LSD) was used to test the differences between treatments means at 0.05level of probability.

RESULTS AND DISCUSSION

Growth:

Results in Table (2) testify the effect of cold storage of bulbs at 5°C for 1, 2, 3, 4 and 5-weeks in the refrigerator before planting as compared to control treatment (room temperature) on the growth of *Narcissus* (leaf length, number of leaves/plant, fresh and dry weight of leaves/plant and sprouting date). It is evident that all growth parameters were improved with all cold storage treatments as compared to control treatment, and were significantly increased with increasing cold storage periods.5-weeks cold storage period recorded the best growth results; also, increasing cold storage gave a short sprout date. The promoted effect of cold storage periods on growth may be due to the stimulatory effect of cold storage on converting the complex stored metabolites in the bulbs to more soluble forms available for plant growth especially by prolonging the storage period (El-Bably and Mahmoud, 2005). Also, may be due to the increase in gibberellin content and activity in the bulbs during cold storage especially by prolonging the period of storage (Nofal *et al*., 2005). The obtained findings are in agreement with those mentioned by Toama *et al.* (2008) and Noy *et al.* (2010) on *Narcissus tazetta*, Gomaa (2000) on tuberose, Soliman (2002) on some ornamental bulbs, El-Bably (2003) on *Antholyza aethiopica* and El-Bably and Mahmoud (2005) on *Tritonia crocata*.

Table (2): Effect of cold storage period and bulb weight on the growth of *Narcissus tazetta* during seasons 2017/2018 and 2018/2019

Characters		Leaf length (cm)		Number of leaves/plant		Fresh weight of leaves/plant (g)		Dry weight of leaves/plant (g)		Sprouting date (days)	
Season		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Treatments		**Cold storage periods (week)**									
Control		26.79	27.76	15.41	16.48	132.98	134.31	6.11	6.89	28.64	27.93
1 Week		28.05	28.73	16.73	17.79	137.31	136.85	7.22	7.67	26.96	26.38
2 Weeks		29.73	29.74	17.74	18.91	139.63	139.98	7.98	8.33	25.49	25.16
3 Weeks		30.65	31.77	18.85	20.21	141.58	142.96	8.55	9.23	23.83	23.07
4 Weeks		31.46	32.81	19.74	21.97	143.76	146.75	9.49	10.03	22.62	21.82
5 Weeks		32.10	33.68	21.12	23.46	146.57	150.34	10.05	11.13	20.23	19.22
$LSD_{0.05}$		2.07	1.89	2.88	1.77	3.42	2.77	1.13	1.07	3.18	2.64
		Bulb weight (g)									
200 g		30.14	31.04	18.71	20.27	141.41	143.08	8.43	9.22	23.95	23.30
150 g		29.82	30.77	18.32	19.79	140.35	141.82	8.21	8.88	24.76	23.95
100 g		29.44	30.44	17.76	19.35	139.16	140.73	8.05	8.54	25.17	24.55
$LSD_{0.05}$		0.33	0.27	0.40	0.19	1.02	1.08	0.06	0.08	1.01	0.71
		Interaction									
Control	**200 g**	27.34	27.99	15.77	17.04	135.25	135.26	6.21	7.11	28.01	27.34
	150 g	26.87	27.84	15.41	16.34	133.45	134.21	6.11	6.79	28.77	28.01
	100 g	26.15	27.44	15.06	16.07	130.24	133.45	6.01	6.77	29.14	28.45
1 Week	**200 g**	28.25	29.01	17.09	18.00	138.24	137.46	7.64	7.99	26.45	26.00
	150 g	28.01	28.78	16.88	17.92	137.24	136.88	7.24	7.67	27.01	26.14
	100 g	27.88	28.40	16.21	17.44	136.44	136.21	6.77	7.34	27.41	27.01
2 Weeks	**200 g**	29.99	30.11	18.11	19.47	140.43	141.34	8.08	8.44	25.00	24.41
	150 g	29.77	29.68	17.92	19.01	139.48	140.11	7.99	8.42	25.47	25.31
	100 g	29.44	29.44	17.19	18.25	138.99	138.49	7.88	8.12	26.01	25.77
3 Weeks	**200 g**	31.05	32.01	19.21	20.75	142.23	144.23	8.78	9.72	23.10	22.71
	150 g	30.78	31.87	18.87	20.02	141.64	142.77	8.44	9.21	24.05	23.00
	100 g	30.11	31.44	18.46	19.87	140.88	141.89	8.42	8.77	24.33	23.49
4 Weeks	**200 g**	31.77	33.21	19.99	22.45	144.33	147.99	9.67	10.22	22.00	21.34
	150 g	31.45	32.77	19.76	22.01	143.75	147.15	9.45	10.11	22.76	22.00
	100 g	31.15	32.45	19.47	21.45	143.21	145.11	9.34	9.770	23.10	22.13
5 Weeks	**200 g**	32.41	33.89	22.11	23.89	147.99	152.01	10.22	11.85	19.16	18.01
	150 g	32.01	33.69	21.07	23.45	146.51	149.77	10.04	11.07	20.48	19.21
	100 g	31.89	33.45	20.18	23.04	145.21	149.24	9.88	10.48	21.04	20.45
$LSD_{0.05}$		3.33	3.18	1.99	2.01	3.07	2.72	1.14	1.08	2.44	3.01

Control: Room temperature

As for the effect of bulb weights (100, 150 and 200 g) on the vegetative growth of *Narcissus*, data of both seasons are shown in Table (2). The leaf length, the number of leaves/plant and fresh and dry weight of leaves/plant were significantly increased with increasing bulb weight. In the same trend, sprouting time was shorted with bulb weight increasing. These results are logic since the heavy weight contains more stored metabolites, necessary for better growth. These results agree with those obtained by Nazki *et al.* (2005), Khan *et al.* (2013), Özel and Erden (2018) on *Narcissus tazetta*, El-Bably (2003) on *Antholyza aethiopica*, Thompson *et al.* (2011) and Kapczyńska (2014) on *Lachenalia*.

Concerning the effect of interaction between cold storage period and bulb weight on growth, the data in Table (2), revealed that all interaction treatments had a significant effect on the vegetative growth of *Narcissus* plants. The heavy bulbs (200 g) that cold stored for 5 weeks gave the highest growth values, on the other hand, the small bulbs (100 g) stored in room temperature recorded the lowest growth values.

Flowering:

Data in Table (3) indicated that, the different cold storage treatments tended to cause a steady and significant precocity in flowering by prolonging cold storage period compared with bulbs stored at room temperature during both seasons, and chilling had very promising effects on the acceleration and earliness of flowering. Increasing cold storage period decreased flowering date and increased both spike and rachis lengths and fresh weight of spike, while the bulbs stored at room temperature increased flowering date and decreased both spike and rachis lengths and fresh weight of spike. The increase in flowering traits may be due to the promoted effect on growth traits that reflected on flowering. In addition, inflorescence initiation occurs during the cold storage period and the temperature must be the most important environmental factor affecting the rate of development at this stage (El-Bably and Mahmoud, 2005). Similar findings obtained by Toama *et al.* (2008) and Noy *et al.* (2010) on *Narcissus tazetta*, El-Bably and Mahmoud (2005) on *Tritonia crocata* and Thompson *et al.* (2011) on *Lachenalia*.

The results in Table (3) demonstrated that bulb weight treatments improved flowering characters (flowering date, spike and rachis lengths and spike fresh weight). There was a significant and gradual increase in spike and rachis lengths and spike fresh weight by increasing bulb weight, while, the flowering date was shorted by increasing bulb weight. The increase in flower characters may be due to the aforementioned reasons in the case of vegetative growth as vigorous growth may reflect on flowers. The present results were conflicted with those of Khan *et al.* (2013) on *Narcissus tazetta* and Thompson *et al.* (2011) on *Lachenalia*.

As regards the interaction between the two studied factors, it is obvious from the results in Table (3) that, the highest values of spike and rachis lengths and spike fresh weight resulted from planting heavy bulbs (200 g) which were stored for 5-weeks at 5^oC, while planting small bulbs (100 g) which stored in room temperature gave the least values. On the other hand, the flowering date was shorten when using big bulbs (200 g) which were stored for 5-weeks at 5°C as compared to small bulbs that stored in room temperature

Flowering quality:

As shown in Table (4) it is interesting to note that, there were significant effects of all cold storage treatments on flowering quality (floret diameter, flowering period and vase-life), except the number of florets/spike in both seasons compared with untreated bulbs (room temperature). Where the significant increase in flowering quality appeared under the longest cold storage period treatment (5-week) compared with the other treatments. Slight and insignificant increment in the number of florets/spike was observed due to prolonging of cold storage period. This character may be due to genotypic of variety (Baker *et al*., 2000). The increase in vase-life by prolonging cold storage period may be due to the enhancement of vegetative growth traits under such conditions, several investigators found that cold storage improved flowering quality *e.g.* Noy *et al.* (2010) on *Narcissus tazetta* and Nofal *et al*. (2005) on *Antholyza aethiopica*.

The results in Table (4) revealed that increasing bulb weight from 100 to 200 g caused a significant increase of floret diameter, flowering period and vase-life, and insignificant differences in the number of florets/spike. In addition, small bulbs give small flowers with low market potential. The increase in flower quality may be due to improve vegetative growth as the vigorous growth may reflect on flowers quality. These results are in agreement with those obtained by Özel and Erden (2018) on *Narcissus tazetta* and Kapczyńska (2014) on *Lachenalia.*

Regarding to the interaction treatments between cold storage and bulb weight, it is evident from data in Table (4) that prolonging cold storage period (5-weeks) coupled with heavy bulbs (200 g) gave the significantly longest floret diameter, flowering period and vase-life, which outranked any other treatments, but the number of florets/spike show insignificant effect by any interaction3treatments. In the same trend, sowing small bulbs stored in room temperature showed the lowest values of flowering quality traits.

Bulb yield components:

It is apparent in Table (5) that increasing cold storage period in both seasons caused a significant and progressive increase in the diameter of the main bulb, fresh weight of main bulb and number of bulbits/plant over control treatment. Where the highest values were obtained from the stored bulbs for 5-weeks at 5^oC, the lowest values were obtained from the stored bulbs in room temperature.

This result was probably due to that prolonging cold storage period led to the accumulation of more soluble metabolites necessary for rapid and vigorous plant growth, which reflected on storing the new bulbits for more reserve materials after the harvesting of spikes. Result of Noy *et al.* (2010) on *Narcissus tazetta* and Nofal *et al.* (2005) on *Antholyza aethiopica* supported our result.

Table (3): Effect of cold storage period and bulb weight on flowering of *Narcissus tazetta* during seasons 2017/2018 and 2018/2019

Characters		Flowering date (days)		Spike length (cm)		Spike fresh weight (g)		Rachis length (mm)	
Season		**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**
Treatments		**Cold storage periods (week)**							
Control		64.10	62.58	29.72	30.80	158.14	162.07	33.48	34.90
1 Week		61.23	60.48	32.16	32.94	163.33	166.90	34.59	36.85
2 Weeks		58.07	56.73	34.44	34.99	169.58	172.18	37.24	38.48
3 Weeks		54.98	54.48	36.24	36.48	174.84	177.12	39.48	40.68
4 Weeks		51.77	52.15	37.44	38.35	178.72	180.66	42.78	42.76
5 Weeks		49.22	49.40	38.70	39.78	184.70	186.69	46.28	45.51
$LSD_{0.05}$		4.31	3.27	1.11	2.31	5.67	4.36	1.13	1.44
		Bulb weight (g)							
200 g		55.57	55.157	35.43	36.21	173.20	176.03	39.67	40.50
150 g		56.56	55.877	34.80	35.55	171.66	174.27	39.06	39.91
100 g		57.55	56.878	34.12	34.92	169.80	172.51	38.20	39.19
$LSD_{0.05}$		1.12	0.82	0.33	0.41	1.43	1.29	0.03	0.11
		Interaction							
Control	**200 g**	62.77	62.09	30.24	31.48	159.45	163.88	33.77	35.21
	150 g	64.31	62.44	29.77	30.77	158.21	162.34	33.47	34.99
	100 g	65.21	63.21	29.14	30.15	156.77	160.00	33.21	34.51
1 Week	**200 g**	60.00	60.00	32.88	33.69	165.21	169.00	35.00	37.48
	150 g	61.44	60.24	32.15	33.01	163.47	166.45	34.77	36.87
	100 g	62.24	61.21	31.45	32.12	161.32	165.24	34.00	36.21
2 Weeks	**200 g**	57.21	56.00	35.44	35.77	172.00	174.22	38.00	39.00
	150 g	58.00	56.74	34.40	35.00	170.00	172.31	37.25	38.45
	100 g	58.99	57.44	33.48	34.19	166.74	170.00	36.48	37.99
3 Weeks	**200 g**	54.30	53.41	37.01	37.21	176.34	178.88	40.00	41.21
	150 g	55.00	54.62	36.24	36.23	174.78	177.00	39.45	40.84
	100 g	55.64	55.41	35.46	36.01	173.41	175.47	38.99	40.00
4 Weeks	**200 g**	51.06	51.44	37.88	38.77	180.00	181.77	44.21	43.88
	150 g	51.48	52.01	37.45	38.41	179.15	181.20	43.21	42.64
	100 g	52.77	53.00	37.00	37.88	177.00	179.00	40.91	41.77
5 Weeks	**200 g**	48.10	48.00	39.11	40.32	186.21	188.41	47.01	46.21
	150 g	49.11	49.21	38.77	39.88	184.33	186.33	46.21	45.64
	100 g	50.44	51.00	38.21	39.15	183.54	185.32	45.61	44.67
$LSD_{0.05}$		3.33	2.97	2.07	1.88	5.16	4.61	2.33	3.18

Control: Room temperature

Table (4): Effect of cold storage period and bulb weight on flower quality of *Narcissus tazetta* during seasons 2017/2018 and 2018/2019

Characters		Number of florets/spike		Floret diameter (mm)		Flowering period (days)		Vase life (days)	
Season		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Treatments		Cold storage periods (week)							
Control		6.12	6.22	34.29	33.91	18.44	18.81	4.33	4.33
1 Week		6.34	6.31	36.50	35.80	19.52	19.52	4.85	4.71
2 Weeks		6.36	6.40	39.56	36.79	21.17	21.55	5.29	5.49
3 Weeks		6.45	6.45	41.93	37.85	22.69	23.29	5.71	6.13
4 Weeks		6.51	6.49	43.08	40.98	23.74	24.51	6.04	6.60
5 Weeks		6.50	6.56	44.42	43.59	24.59	24.96	6.32	7.01
$LSD_{0.05}$		N.S	N.S	1.79	2.04	1.10	0.87	1.13	1.08
		Bulb weight (g)							
200 g		6.41	6.42	40.50	38.50	22.07	22.44	5.59	5.89
150 g		6.36	6.41	40.03	38.18	21.71	22.11	5.41	5.68
100 g		6.37	6.39	39.36	37.79	21.30	21.77	5.28	5.57
$LSD_{0.05}$		N.S	N.S	0.11	0.23	0.29	0.42	0.18	0.09
		Interaction							
Control	200 g	6.11	6.23	34.99	34.25	18.77	19.00	4.67	4.43
	150 g	6.15	6.21	34.67	34.01	18.33	18.77	4.22	4.31
	100 g	6.11	6.22	33.21	33.47	18.21	18.66	4.11	4.26
1 Week	200 g	6.44	6.33	37.24	36.00	19.88	19.87	4.90	4.88
	150 g	6.34	6.29	36.48	35.74	19.67	19.44	4.88	4.69
	100 g	6.24	6.31	35.78	35.66	19.01	19.24	4.76	4.55
2 Weeks	200 g	6.44	6.41	40.47	37.00	21.88	22.00	5.45	5.69
	150 g	6.22	6.44	39.45	36.89	21.01	21.64	5.32	5.46
	100 g	6.42	6.34	38.77	36.48	20.63	21.01	5.11	5.31
3 Weeks	200 g	6.46	6.46	42.31	38.12	23.00	23.99	5.88	6.27
	150 g	6.45	6.46	41.88	37.88	22.77	23.14	5.71	6.11
	100 g	6.44	6.44	41.61	37.55	22.31	22.74	5.55	6.00
4 Weeks	200 g	6.50	6.50	43.37	41.61	24.00	24.77	6.21	6.88
	150 g	6.52	6.49	43.21	41.00	23.77	24.66	6.00	6.52
	100 g	6.51	6.47	42.67	40.34	23.44	24.11	5.91	6.41
5 Weeks	200 g	6.50	6.570	44.62	44.00	24.89	25.00	6.41	7.12
	150 g	6.50	6.570	44.51	43.55	24.68	25.00	6.33	7.00
	100 g	6.49	6.550	44.13	43.21	24.21	24.88	6.22	6.90
$LSD_{0.05}$		N.S	N.S	3.77	4.35	2.08	1.84	0.99	1.02

Control: Room temperature

Results in Table (5) reveal the effect of bulb weight (100, 150 and 200 g) on the diameter and fresh weight of the main bulb as well as the number of bulbits/plant, it is evident that increasing the bulb yield was seen concomitantly with increasing bulb weight. This may be due to the heavy bulbs producing a higher number of bulbils. The increase in the fresh weight of the main bulb may be due to the aforementioned reasons in case of vegetative growth as the vigorous growth may reflect on the production of heavier bulbs. These results were in agreement with those obtained by Nazki *et al.* (2005), Khan *et al.* (2013), Özel and Erden (2018) on *Narcissus tazetta* and El-Bably (2003) on *Antholyza aethiopica*, as well as Thompson *et al.* (2011) and Kapczyńska (2014) on *Lachenalia.*

Concerning the interaction between the two studied factors, data in Table (5) proved that the longest cold storage (5-weeks) with the heavy bulbs (200 g) recorded the highest values of diameter and fresh weight of the main bulb as well as number of bulbits/plant compared with the other interaction treatments. Meanwhile, small bulbs stored in room temperature recorded the lowest values of these traits.

Table (5): Effect of cold storage period and bulb weight on bulbs yield components of *Narcissus tazetta* during seasons 2017/2018 and 2018/2019

Characters		Diameter of main bulb (cm)		Fresh weight of main bulb (g)		Number of bulbits/ plant	
Season		**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**
Treatments		**Cold storage periods (week)**					
Control		7.33	7.54	95.07	97.01	4.52	4.46
1 Week		8.09	7.99	121.47	118.99	5.20	5.15
2 Weeks		8.69	8.57	165.16	136.22	6.26	5.89
3 Weeks		9.47	9.19	194.08	165.59	7.35	6.60
4 Weeks		10.24	9.84	209.58	206.03	8.06	7.20
5 Weeks		10.74	10.63	229.17	224.23	8.43	7.90
$LSD_{0.05}$		1.08	0.92	4.69	5.31	1.62	1.77
		Bulb weight (g)					
200 g		9.28	9.18	174.81	163.55	6.92	6.41
150 g		9.10	8.96	169.59	158.04	6.61	6.19
100 g		8.91	8.75	162.87	152.45	6.38	6.00
$LSD_{0.05}$		0.11	0.30	2.49	3.62	0.22	0.33
		Interaction					
Control	**200 g**	7.44	7.66	99.67	99.21	4.87	4.65
	150 g	7.34	7.54	94.77	97.46	4.47	4.41
	100 g	7.21	7.42	90.77	94.36	4.21	4.33
1 Week	**200 g**	8.25	8.22	130.42	123.00	5.39	5.44
	150 g	8.14	7.99	123.77	118.67	5.21	5.21
	100 g	7.89	7.77	110.21	115.31	5.01	4.79
2 Weeks	**200 g**	9.00	8.73	172.31	142.20	6.79	6.00
	150 g	8.75	8.56	166.47	137.14	6.21	5.87
	100 g	8.33	8.41	156.69	129.33	5.77	5.80
3 Weeks	**200 g**	9.77	9.44	200.18	175.11	7.69	6.90
	150 g	9.44	9.14	192.33	163.44	7.34	6.60
	100 g	9.21	9.00	189.74	158.23	7.01	6.29
4 Weeks	**200 g**	10.33	10.00	211.67	213.44	8.21	7.49
	150 g	10.21	9.87	209.77	207.33	7.99	7.12
	100 g	10.17	9.66	207.31	197.33	7.99	7.00
5 Weeks	**200 g**	10.88	11.00	234.60	228.34	8.55	8.00
	150 g	10.72	10.66	230.45	224.21	8.42	7.90
	100 g	10.62	10.23	222.47	220.14	8.31	7.80
$LSD_{0.05}$		1.49	2.01	5.66	4.12	4.66	3.08

Control: Room temperature

Chemical contents of dry leaves:

Data in Table (6) show the effect of the cold storage period of bulbs on mineral contents of dry leaves. Cold storage treatments showed gradual increases in NPK contents of leaves compared with control treatment (room temperature) in both seasons. The highest NPK contents were recorded with the longest period of cold storage (5-week) with significant differences compared to control. The promoting effect of cold storage treatments on NPK content in the leaves may be due to the enhancement of vegetative growth and acceleration of sprouting, which allowed more absorption of such elements from the soil as reflected on increasing its content in the leaves. This result explains the action of cold storage on improving the growth through the stimulation of enzymatic phosphorus system. Similar results were obtained by El-Bably (2003) on *Antholyza aethiopica*, El-Bably and Mahmoud (2005) on *Tritonia crocata.*

As obvious from Table (6), the bulb weight has significant effects on NPK contents in the dry leaves of Narcissus, heavy bulbs (200 g) recorded significant increases in NPK contents as compared to small bulbs (100 g). These results supported by the results recorded by Özel and Erden (2018) on *Narcissus tazetta* and Kapczyńska (2014) on *Lachenalia*.

As regards the interaction between the study factors, it is obvious from the results in Table (6) that, the highest values of NPK contents resulted from using heavy bulbs (200 g), which were stored for 5-weeks at 5°C. Meanwhile, sowing the small bulbs (100 g) which were stored in room temperature recorded the lowest NPK values with insignificant differences in most cases.

Table (6): Effect of cold storage period and bulb weight on NPK content in *Narcissus tazetta* leaves during seasons 2017/2018 and 2018/2019

Characters		Nitrogen %		Phosphorus %		Potassium %	
Season		1st season	2nd season	1st season	2nd season	1st season	2nd season
Treatments		Cold storage periods (week)					
Control		0.79	0.79	0.44	0.45	0.70	0.71
1 Week		0.85	0.85	0.47	0.47	0.74	0.74
2 Weeks		0.90	0.90	0.50	0.51	0.77	0.77
3 Weeks		0.94	0.95	0.55	0.54	0.82	0.81
4 Weeks		0.98	0.99	0.59	0.57	0.86	0.83
5 Weeks		1.01	1.02	0.59	0.60	0.90	0.85
$LSD_{0.05}$		0.16	0.12	0.08	0.06	0.12	0.08
		Bulb weight (g)					
200 g		0.93	0.94	0.54	0.54	0.82	0.81
150 g		0.91	0.92	0.52	0.52	0.80	0.79
100 g		0.89	0.90	0.51	0.51	0.78	0.77
$LSD_{0.05}$		0.03	0.02	0.01	0.02	0.03	0.02
		Interaction					
Control	200 g	0.80	0.82	0.46	0.46	0.72	0.73
	150 g	0.79	0.79	0.44	0.45	0.70	0.70
	100 g	0.78	0.77	0.43	0.44	0.68	0.70
1 Week	200 g	0.88	0.87	0.49	0.49	0.75	0.76
	150 g	0.83	0.85	0.47	0.47	0.74	0.75
	100 g	0.83	0.83	0.46	0.45	0.72	0.72
2 Weeks	200 g	0.91	0.92	0.52	0.53	0.79	0.79
	150 g	0.90	0.89	0.49	0.50	0.77	0.77
	100 g	0.88	0.89	0.49	0.49	0.75	0.75
3 Weeks	200 g	0.96	0.97	0.57	0.56	0.84	0.83
	150 g	0.94	0.95	0.55	0.53	0.82	0.81
	100 g	0.92	0.93	0.53	0.52	0.80	0.79
4 Weeks	200 g	0.99	1.01	0.60	0.59	0.88	0.86
	150 g	0.98	0.99	0.59	0.58	0.86	0.84
	100 g	0.96	0.98	0.57	0.55	0.83	0.80
5 Weeks	200 g	1.04	1.06	0.62	0.63	0.94	0.88
	150 g	0.99	1.02	0.58	0.60	0.88	0.85
	100 g	0.99	0.99	0.58	0.58	0.88	0.83
$LSD_{0.05}$		0.23	0.17	0.09	0.07	0.04	0.05

Control: Room temperature

Some active ingredients and antioxidant activity in the dry bulb:

Data regarding the total phenols, total flavonoids and antioxidant activity in dry bulbs of *Narcissus tazetta* during the two seasons were recorded in Table (7). Total phenols arranged from 325.51 to 553.44mg/100g, total flavonoids arranged from 774.30 to 1412.69 mg/100 g and antioxidant activity arranged from 26.50 to 41.88% in the two seasons. Total phenols, total flavonoids and antioxidant activity were significantly increased by increasing the cold storage period up to 2-week. Cold storage for 2-week gave significant increases in these components compared to control and the other cold storage treatments for the first and second seasons. The lowest content of these components was obtained by the longest cold storage period in most cases.

All active ingredients under study were significantly affected by the bulb weight as clear in Table (7). Total flavonoids and antioxidant activity in dry bulbs were significantly increased by decreasing bulb weight. While, the highest contents of total phenols were recorded with the medium weight (150g/bulb), the lowest weight (100 g/bulb) gave the highest contents of both total flavonoids and antioxidant activity with significant differences in the two seasons. The lowest contents of all these components were obtained with the highest weight (200 g/bulb) for both seasons.

While the interaction treatment between 2-week cold storage and 150 g/bulb weight recorded the highest values of total phenols for the two seasons and total flavonoids in the first one, the interaction treatment between 2-week cold storage and 100g/bulb recorded the highest content of total flavonoids in the second season, and the highest antioxidant activity in both seasons, with significant differences compared to the other treatments. The lowest phenols content was recorded with the interaction treatment between 4-week cold storage and 100 g/bulb in the two seasons. Interaction between 5-week cold storage and both of 150 g and 100 g/bulb recorded the lowest contents of total flavonoids and antioxidant activity, respectively, for both seasons with significant differences compared to all other treatments.

Table (7): Effect of cold storage period and bulb weight on some active ingredients in *Narcissus tazetta* bulbs during seasons 2017/2018 and 2018/2019

Characters		Total Phenols mg/100g d.w.		Total Flavonoids mg/100 g d.w.		Antioxidant activity %	
Season		**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**
Treatments		**Cold storage periods (week)**					
Control		465.54	463.94	1041.11	1048.02	33.65	33.17
1 Week		477.62	470.44	1152.93	1140.76	36.27	34.52
2 Weeks		553.44	546.17	1412.69	1366.62	41.37	41.88
3 Weeks		373.56	371.11	994.77	1019.10	26.50	27.91
4 Weeks		358.44	375.19	1196.27	1140.09	27.72	28.64
5 Weeks		330.47	325.51	817.48	774.30	27.45	26.98
$LSD_{0.05}$		7.28	4.30	18.68	14.07	0.84	0.43
		Bulb weight (g)					
200 g		398.19	396.18	1036.17	1010.05	29.63	30.19
150 g		454.77	465.98	1115.18	1071.21	31.45	32.56
100 g		426.57	414.02	1156.26	1163.20	35.39	33.80
$LSD_{0.05}$		5.04	5.53	14.04	10.01	0.30	0.29
		Interaction					
Control	**200 g**	399.85	398.26	953.29	984.20	26.33	25.92
	150 g	495.03	505.39	911.41	930.36	34.29	34.40
	100 g	501.73	488.18	1258.62	1229.51	40.33	39.19
1 Week	**200 g**	356.77	338.96	1004.25	899.95	26.68	26.40
	150 g	500.77	495.75	1314.27	1324.24	39.47	38.28
	100 g	575.33	576.62	1140.26	1198.10	42.66	38.88
2 Weeks	**200 g**	427.34	429.90	1001.75	996.17	33.17	34.680
	150 g	680.56	687.26	1676.74	1542.12	38.76	41.493
	100 g	552.42	521.34	1559.57	1561.56	52.18	49.463
3 Weeks	**200 g**	434.07	446.09	1262.41	1274.38	28.63	31.07
	150 g	332.15	339.18	847.69	845.10	24.21	26.58
	100 g	354.45	328.07	874.21	937.84	26.67	26.09
4 Weeks	**200 g**	407.94	430.42	1030.57	1021.60	31.81	32.72
	150 g	397.94	413.11	1226.02	1088.41	24.44	26.40
	100 g	269.44	282.03	1332.22	1310.28	26.90	26.81
5 Weeks	**200 g**	363.20	333.45	964.76	883.99	31.19	30.37
	150 g	322.18	355.17	714.97	697.02	27.54	28.18
	100 g	306.03	287.92	772.70	741.89	23.63	22.38
$LSD_{0.05}$		12.35	13.55	34.40	24.37	0.74	0.70

Control: Room temperature

Essential oil components:

Data regarding essential oil components in *Narcissus* flowers illustrated in Table (8).They reveal that the main identified components were β-Ocimene (45.31-81.46%), Limonene (1.02-9.56%), 1,8-Cineole (0.72-5.40%), Linalool (0.41-8.91%), Benzyl acetate (0.78-13.83%) and β-Caryophyllene (4.12-22.33%). Cold storage treatments recorded differences in essential oil components, whereas 4-week cold storage gave the highest content of β-Ocimene, 1-week recorded the highest content of Limonene. While the highest contents of 1,8-Cineole and Linalool were obtained by cold storage for 2-week, the highest content of β-caryophyllene was obtained by cold storage for 3-week.Moreover, the bulbs storage at room temperature (control) recorded the highest Benzyl acetate content. Furthermore, the lowest contents of most of these components were obtained with 4 and 5-week cold storage treatments.

As shown in Table (8) essential oil constituents were affected by bulb weight, 200 g bulbs gave the highest content of 1,8-Cineole and Benzyl acetate, but 150 g bulbs gave the highest content of both Limonene and Linalool. While the highest contents of β-Ocimene and β-caryophyllene were obtained with bulbs have 100 g weight. The highest weight (200 g) of bulb gave the lowest values of β-Ocimene, Linalool and β-caryophyllene, whereas the lowest weight (100 g) recorded the lowest values of Limonene and Benzyl acetate.

The interaction between 1-week cold storage and bulb weights 200 and 150 g recorded the highest content of both Limonene and Linalool, respectively. While bulbs have 200 and 100 g weight were stored at room temperature (control) gave the highest content of both Benzyl acetate and β-caryophyllene, respectively, the lowest bulb weight (100 g) with 2-week cold storage period recorded the highest content of 1,8-Cineole. The long cold storage periods (4 and 5-week) with 100 and 150 g bulbs recorded the highest content of β-Ocimene.

CONCLUSION

From the obtained results, it could be concluded that the highest values of vegetative growth, flower quality and early flowering, vase-life and bulb yield were obtained by the interaction between the longest periods of cold storage (5-weeks) with the highest bulb weight (200 g). Whereas the higher values of active ingredients in dry bulbs, especially antioxidants activity were recorded by the interaction between the cold storage period of 2-weeks with weights 150 and 100 g/ bulb, in both seasons. All treatments gave differences in essential oil components of flowers.

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Table (8): Effect of bulbs weight and cold storage periods of bulbs on essential oil components of *Narcissus tazetta* L. cv. Cheerfulness during the season 2018-2019

Component %	Treatments													
	Control			1 week			2 weeks		3 weeks		4 weeks	5 weeks		
	200g	150g	100g	200g	150g	100g	200g	100g	200g	150g	100g	200g	150g	100g
β-Ocimene	60.56	58.99	62.63	60.30	54.47	69.29	55.21	64.23	65.71	62.63	81.46	73.50	81.46	45.31
Limonene	9.19	8.77	----	9.56	9.06	----	9.03	3.93	3.67	----	----	----	----	1.02
1,8-Cineole	3.58	3.41	0.96	1.48	----	1.57	----	5.40	4.78	0.96	2.43	0.72	2.43	----
Linalool	2.66	2.54	3.25	2.77	8.91	4.50	8.69	6.49	5.23	3.25	----	0.41	----	1.79
Benzyl acetate	13.83	13.20	2.07	13.53	11.16	0.55	11.33	7.16	8.18	2.06	0.78	0.37	0.78	9.02
β-Caryophyllene	7.22	6.89	22.33	6.79	5.84	----	6.23	8.64	8.62	22.33	4.86	4.12	4.86	20.76
Identified components	97.04	93.80	91.24	94.43	89.44	75.91	90.49	95.85	96.19	91.23	89.53	79.12	89.53	77.90

Component %	Means of Treatments									
	200g	150g	100g	Control	1 weeks	2 weeks	3 weeks	4 weeks	5 weeks	Mean comp.
β-Ocimene	63.06	64.39	64.58	60.73	61.35	59.72	64.17	81.46	66.76	64.01
Limonene	7.86	8.92	2.48	8.98	9.31	6.48	3.67	----	1.02	6.09
1,8-Cineole	2.64	2.27	2.59	2.65	1.53	5.40	2.87	2.43	1.58	2.66
Linalool	3.95	4.90	4.01	2.82	5.39	7.59	4.24	----	1.10	4.25
Benzyl acetate	9.45	6.80	3.92	9.70	8.41	9.25	5.12	0.78	3.39	6.31
β-Caryophyllene	6.60	9.98	14.15	12.15	6.32	7.44	15.48	4.86	9.91	9.56
Identified components	93.56	97.26	91.73	97.03	95.31	95.88	95.55	89.53	83.76	

Control: Room temperature

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تأثير التخزين البارد للأبصال ووزن البصلة على النمو والتزهير ومكونات الزيت العطري ومكونات البصلة الفعالة في نبات النرجس

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يهدف هذا العمل لدراسة تأثيرات فترات التخزين البارد لأبصال النرجس: ١ ، ٢ ، ٣ ، ٤ و ٥ أسبوع على درجة ٥ مئوية بالإضافة لدرجة حرارة الغرفة (كنترول)، ووزن البصلة: ٢٠٠ ، ١٥٠ و١٠٠±٥جم ومعاملات التفاعل بينهما على النمو الخضري، الإزهار، محتوى الأوراق من العناصر وبعض المواد الفعالة في أبصال النرجس وكذلك مكونات الزيت العطري بالإزهار بالمزرعة البحثية لمحطة بحوث البساتين بالقصاصين خلال موسمي ٢٠١٨/٢٠١٧ و ٢٠١٩/٢٠١٨. أظهرت النتائج تأثيرات إيجابية للتخزين البارد وحجم البصلة وكذلك التفاعل بينهما على النمو، التزهير وإنتاجية الأبصال ومحتواها من المواد الفعالة. القيم الأعلى لكلٍّ من النمو الخضري، جودة الأزهار وتبكيره ومحصول الأبصال والمحتوى المعدني للأوراق الجافة تم الحصول عليها بالتفاعل بين الفترة الأطول للتخزين البارد (٥ أسابيع) مع الوزن الأكبر للبصلة (٢٠٠ جم). بينما سجلت القيم الأعلى من المواد الفعالة في الأبصال الجافة خاصة نشاط مضادات الأكسدة بالتفاعل بين فترة التخزين البارد لأسبوعين مع أوزان ١٥٠ و ١٠٠ جم/بصلة، وسُجلت هذه النتائج في كلا الموسمين. كل المعاملات أعطت اختلافات في مكونات الزيت العطري لأزهار النرجس.

الكلمات الدالة: النرجس، التخزين المبرد، حجم البصلة، النمو والتزهير، المواد الفعالة، الفينولات، الفلافونيدات، نشاط مضادات الأكسدة، مكونات الزيت العطري.