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RESPONSE OF PAPERWHITE NARCISSUS PLANT TO NITROGEN AND POTASSIUM FERTILIZATION LEVELS UNDER SANDY SOIL CONDITIONS

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ABSTRACT: This research included two experiments on paperwhite narcissus plant grown under sandy soil conditions at the Experimental Farm of Efficient Productivity Institute, Zagazig University. The first experiment was carried out during the two successive seasons of 2003/04 and 2004/ 05 aiming to study the effect of four nitrogen levels (0, 50, 100, and 200 ppm), four potassium levels (0, 100, 200, and 300 ppm), as weekly doses in 200 cc solution/ pot, and their interactions on characteristics of produced round and split bulbs. While, the second experiment was conducted during 2004/ 05 and 2005/ 06 seasons to evaluate the residual effect of the above mentioned treatments on subsequent vegetative growth, flowering and leaf chemical analyses of plants resulted from replanting the previously fertilized round bulbs which resulted from the first experiment.

Among the tested fertilizer levels, nitrogen at 100 ppm or K at 300 ppm applied each alone significantly increased circumference and dry weight of round bulb. The produced number of split bulbs/ plant was increased by 100 ppm N, while K at 100 ppm resulted in the highest dry weight of split bulb. Nitrogen at 100 ppm interacted with 200 ppm potassium level increased dry weight and circumference/ round bulb. Moreover, the same interaction treatment had the superior enhancing residual effect on subsequent flowering aspects (flowering stalk length, florets No/ plant and flowering plant longevity) as well as N% in leaf tissues of plants resulted from replanting fertilized round bulbs comparing to the other interaction treatments.

Simple correlation coefficients under interaction treatments (N x K) effect exhibited positive and significant interrelationships between circumference of planted round bulb and leaf chemical constituents (N, P, K and total carbohydrates percentages) in resulted plant, as well as between plant leaf chemical constituents and its growth and flowering parameters.

Key words: Paperwhite narcissus, nitrogen, potassium, bulb production, flowering, growth, chemical analyses and residual effect.

INTRODUCTION

"Paperwhite" *Narcissus* (*Narcissus tazetta*) is one of the easiest flower ulbs for home-owners to force (DeHertogh, 1998). It is spring-flowering bulbs require very little care and flower reliably year after year. It is well-suited to many landscape design uses, including in front of shrubbery, under large trees, and in rock or perennial gardens. Also, it is best to grow in a container filled with either coarse materials (e.g. pebbles, gravel, and beads) and water or potting soil (Dana and Lerner, 2001). It is bloom rapidly in about 5 weeks from planting and possible to set them outside on balconies, porches, or decks to prolong the bloom (Helbacka, 2002). It is native to the western Mediterranean and can produce between two to 20 small fragrant white flowers on each flowering stalk (BBC.CO.UK, 2008).

According to Jones (1982), nitrogen constitutes integral part of amino acids, which form enzymes and protein. It is also a part of the chlorophyll molecule. Also, potassium is essential for various growth processes including cell division, photosynthesis and formation of carbohydrates, translocation of sugar, reduction of nitrates and subsequent synthesis into proteins and enzyme activity. So, N and K contribute in carbohydrate synthesis and translocation to storage organs. This means that suitable combinations of N and K will yield bulbs contain more carbohydrates and other metabolites and this in turn enhance subsequent growth and flowering of plants resulted from replanting these bulbs.

Dana and Lerner (2001) stated that narcissi grow adequately in many soil types. The soil should be of average fertility. High fertility,

particularly in nitrogen, promotes excessive leaf growth at the expense of high-quality flower production, as well as the excessive splitting of bulbs. Black *et al.* (2003) published that general bulb care includes fertilization once or twice during the growing season with a special bulb fertilizer or 1 or 1.5 lbs of 12-4-8 or an equivalent amount of other complete fertilizers per 10 m^2 of bed. Groth (2004) stated that the period after paperwhite narcissus blooms fade is a crucial time for adding bulb food (high in potassium) to the ground around bulbs for next year's performance. Also, an established bulb bed may benefit from a nitrogen fertilizer application at the beginning of the growing season. Christman (2005) recommended using a balanced fertilizer such as 5-10-15 or 6-24-24 in late winter, before the foliage breaks ground and again immediately after blooming. Also, Trinklein (2007) stated that daffodils do not require heavy fertilization. When preparing the beds, only 2 to 3 pounds of a complete garden fertilizer such as a 6-24-24 or other fertilizer with a 1:4:4 or 1:3:3 N-P-K ratio/ 100 square feet of soil is convenient to use. When planting bulbs in clumps, about a handful fertilizer per 12 bulbs is adequate.

Effect of N on growth of other bulbous plants was previously studied with some details. On onion plant, El-Gamili and Abd El-Hadi (1996) and Sharma (1998) investigated plant height and leaves number/ plant, Kumar *et al.* (1998) studied bulb diameter and bulb dry weight, as well as Dawa and El-Mansi (1999) and Rodriguez *et al.* (2000) recorded leaves No/ plant and plant height as affected by N applications. The all concluded that N fertilizer increased the above mentioned growth parameters. Also, garlic plant height and bulb diameter were significantly increased by N applications (El-Seifi *et al.*, 2004).

Respecting potassium, Nagaich *et al.* (1999) reported that fertilization onion plant with 80 Kg K_2O/ *ha* significantly increased bulb horizontal diameter and plant dry weight.

Ibraheim (2004) studied the effect of N and K as fertigation at rates of 60 Kg N + 75 Kg K_2O, 80 Kg N + 100 Kg K_2O or 100 Kg N + 125 Kg K_2O/ *fed* and found that the highest level significantly increased onion plant height, leaves No/ plant, dry weight of

leaves and bulb/ plant, and total uptake of N, P and K.

According to the available literature there were no definite information regarding the effect of different doses of N, K and their interactions under sandy soil conditions on paperwhite narcissus bulb production and on subsequent growth. So, this research was conducted in two experiments aiming, in the first experiment, to study the effect of four nitrogen levels, four potassium levels and their interactions under sandy soil conditions on characteristics of produced round and split bulbs, and the objective of the second experiment was to evaluate the subsequent residual effect of the above mentioned treatments on vegetative growth, flowering and leaf chemical analyses of paperwhite narcissus plants resulted from replanting the previously fertilized round bulbs.

MATERIALS AND METHODS

This research was conducted at the Experimental Farm of Efficient Productivity Institute, Zagazig University including two experiments. The first experiment was carried out during 2003/ 04 and 2004/ 05 seasons to study the effect of N and K levels and their interactions on characteristics of produced round and split bulbs of paperwhite narcissus under sandy soil conditions. While, the second experiment was conducted during 2004/ 05 and 2005/ 06 seasons aiming to evaluate the residual effect of the previously mentioned treatments on vegetative growth, flowering and leaf chemical analysis of plants resulted from replanting the fertilized round bulbs obtained from the first experiment.

Each of the two experiments of this research included 16 treatments, which were the combinations between 4 nitrogen levels; *i.e.*, 0 (control), 50, 100 and 200 ppm and 4 potassium levels; *i.e.*, 0 (control), 100, 200 and 300 ppm. The experimental design was factorial between the above mentioned nitrogen and potassium levels in a complete randomized block design with four replicates, each replicate contained six pots and each pot contained two bulbs.

Procedures

First experiment

Uniform round bulbs of *Narcissus tazetta* cultivar paperwhite, average 11 cm in circumference (non flowering

size), were used in this study. On September 1st, for the two seasons of 2003/ 04 and 2004/ 05, two round bulbs were planted/ 20 cm plastic pot filled with sandy soil. The physical and chemical properties of the used sandy soil were 56.6% coarse sand, 38.1% fine sand, 3.6% silt, 1.7% clay, EC 1.81 dS m^{-1}, 7.56 pH, 0.05% organic matter, 13.6 ppm available N, 10.7 ppm available P and 64.3 ppm available K.

Nitrogen and potassium fertilizer treatments were applied as weekly doses, each dose was in 200 cubic centimeters solution per pot, beginning one month after planting (October 1st) and terminating on June 1st for the two seasons. Tap water was used for fertilizer dissolving. All treatments received 1 g triple super-phosphate (37.5% P_2O_5)/ pot at planting time, and were sprayed on December 1st with solution contained Fe, Mn and Zn at 50 ppm for each (produced by OTO Company as EDTA compounds) to encourage growth.

Nitrogen levels; *i.e.*, 0 (control), 50, 100 and 200 ppm were supplied in the form of ammonium sulphate (20.5 % N). This was equal to 0, 10, 20 and 40 mg N/ pot/ week and 0, 320, 640, 1280 mg N/ pot/ season, respectively. While potassium levels; *i.e.*, 0, 100, 200, 300 were supplied as potassium sulphate (50% K_2O) form. This was equal to 0, 20, 40 and 60 mg K_2O/ pot / week and 0, 640, 1280 and 1920 mg K_2O/ pot/ season, respectively.

On July 15th, 2004 and 2005, when the foliage completely turned yellow and were died back, bulbs were dug out, cleaned, separated and cured in ventilated shady place as well as round and split bulb characteristics were recorded. Then, the dormant round bulbs for each treatment were stored separately during the summer.

Second experiment

Stored round bulbs, yield of the first experiment, of each fertilizer treatment were separately replanted on September 1st for seasons of 2004/ 05 and 2005/ 06 to determine the fertilizer treatments residual effect (the objective of this research part). Two round bulbs were replanted per 20 cm plastic pot filled with the same sandy soil described above in the first experiment.

Recorded Data

First experiment

During bulb production seasons of 2003/ 04 and 2004/ 05 the

majority of plants did not flower because the beginning used bulb size was less than the flowering size (average 11 cm in circumference). So, the treatments effect was recorded during these seasons only on bulb characteristics. The recorded bulb characteristics included dry weight of round bulb (g), round bulb circumference (cm), produced split bulb number/ plant and dry weight of split bulb (g).

Second experiment

Recorded residual effect data during 2004/ 05 and 2005/ 06 seasons included:

Vegetative growth and flowering

Vegetative growth and flowering data were recorded at flowering time as average produced leaves No/ plant, leaf length (cm), flowering stalk length (cm), produced florets No/ plant and the plant longevity expressed as days number from opening the first floret to the time of which 50 % of the opening florets/ plant were faded.

Chemical analyses

Leaf samples for chemical analyses were taken after two months from replanting the round bulbs (on November 1st) in both seasons and were dried at 70 °C for 72 hours, finely grounded and wet digested to determine total nitrogen percentage according to A.O.A.C. (1980), total phosphorus percentage according to Hucker and Catroux (1980), potassium percentage according to Jackson (1970), and total carbohydrates percentage according to Dubois *et al.* (1956). Pots which used for chemical samples were canceled from vegetative and flowering determinations.

Statistical Analysis

The collected data of the two experiment parts were subjected to statistical analysis according to Steel and Torrie (1980). Mean separation was done using Duncan's multiple range test at 5% level (Duncan, 1958). Also, correlation coefficients were calculated according to Svab (1973)

RESULTS AND DISCUSSION

First Experiment: Effect of Nitrogen, Potassium and Their Interaction Treatments on Produced Bulb Characteristics

Effect of nitrogen

Obtained results in Table 1 indicate that weekly fertilization of narcissus plant with solution containing 100 ppm N significantly increased average dry

weight/ round bulb (g) and circumference/ round bulb (cm) comparing to control and low (50 ppm) or high (200 ppm) N levels. This was true during the two tested seasons. Also the same Table clears that N at 100 or 200 ppm enhanced split bulb production/ plant comparing to 0 in the two seasons or 50 ppm N in the second season. While, 50 ppm N significantly increased average dry weight/ split bulb comparing to the other N levels. However, Dana and Lerner (2001) stated that high nitrogen levels promote excessive splitting of narcissi bulbs. Similar results were previously recorded respecting bulb diameter and bulb dry weight by Kumar *et al.* (1998) on onion and El-Shabasi *et al.* (2003) as well as El-Seifi *et al.* (2004) on garlic. According to Jones (1982), nitrogen constitutes integral part of amino acids, which form enzymes and protein. It also is a part of the chlorophyll molecule. So, it plays an important role in carbohydrate synthesis and its translocation into storage organs.

Table 1. Round and split bulb production of paperwhite narcissus as affected by nitrogen and potassium under sandy soil conditions during 2003/ 04 and 2004/ 05 seasons

Treatments	Average dry weight/ round bulb (g)		Circumference/ round bulb (cm)		Produced split bulb No/ plant		Average dry weight/ split bulb (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Nitrogen levels (ppm)								
0	8.88c	9.18c	12.4c	11.8c	2.40b	2.66c	1.12b	1.08b
50	9.73b	9.47b	13.0b	13.0b	3.36a	2.89b	1.18a	1.16a
100	10.5a	10.6a	14.2a	14.1a	3.45a	3.59a	0.79d	1.00c
200	8.84c	9.60b	13.1b	13.3b	3.45a	3.51a	0.96c	0.93d
Potassium levels (ppm)								
0	7.61d	7.70c	12.1c	11.7c	3.03a	2.81c	0.98b	0.95c
100	9.23c	9.76b	12.9b	13.1b	3.15a	3.03b	1.07a	1.10a
200	10.1b	10.7a	13.8a	13.4b	3.30a	3.38a	0.96b	1.07ab
300	11.0a	10.7a	13.9a	14.0a	3.19a	3.42a	1.03a	1.05b

Means having same alphabetical letter (s) within each column did not significantly differ according to Duncan's multiple range test at 5% level.

Effect of potassium

Table 1 shows that as K fertilizer level increased up to the highest level (300 ppm) growth of produced round bulbs expressed as average dry weight and circumference of round bulb was significantly increased. The highest round bulb growth was recorded under the effect of the highest K level, while the highest split bulb weight was obtained by using the low K level (100 ppm) during the two growth seasons. Potassium did not exhibit clear trend during the two seasons regarding split bulb production/ plant. Nagaich *et al.* (1999) reported that fertilization of onion plant with 80 Kg K_2O/ *ha* significantly increased bulb horizontal diameter. Groth, (2004) recommended adding bulb food (high in potassium) to the ground around bulbs during the period after paperwhite narcissus blooms fade for next year's performance. However, the enhancing effect on bulb growth might be due to K vital role for various growth processes including cell division, photosynthesis and formation of carbohydrates, translocation of sugar, reduction of nitrates and subsequent synthesis into proteins and enzyme activity as mentioned by Jones (1982).

Effect of interaction between nitrogen and potassium

Data in Table 2 which represented effect of interaction between nitrogen and potassium levels indicate that, generally, increasing the interacted K level under any N level increased dry weight and circumference of round bulb. The highest round bulb weight and circumference were noticed under the effect of 100 ppm N interacted with 200 or 300 ppm K treatments, with no significant differences between them during the two tested seasons. Split bulb production/ plant did not significantly affect with interaction treatments. While, dry weight of split bulb recorded the highest values under the effect of 50 ppm N interacted with 200 or 300 ppm K. Similar enhancing effect regarding bulb weight was recorded on onion by interacting 100 Kg N + 125 Kg K_2O/ *fed* (Ibraheim, 2004). However, the synergistic effect of N with K respecting photosynthesis and translocation of carbohydrates and other metabolites from leaves to storage bulbs might be the responsible for increasing bulb weight and circumference.

Table 2. Round and split bulb production of paperwhite narcissus as affected by interaction treatments between nitrogen and potassium levels under sandy soil conditions during 2003/ 04 and 2004/ 05 seasons

Interaction treatments		Average dry weight/ round bulb (g)		Circumference/ round bulb (cm)		Produced split bulb No/ plant		Average dry weight/ split bulb (g)	
N level ppm	K level ppm	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	0	7.22i	7.37e	11.2a	10.6g	2.25a	2.20a	1.09cd	0.79h
0	100	8.42fg	8.96c	11.9a	11.5fg	2.40a	2.55a	1.11bcd	1.11cde
0	200	9.61e	10.1b	13.2a	11.9ef	2.47a	3.00a	1.14abcd	1.15bcd
0	300	10.3d	10.3b	13.5a	13.1cd	2.50a	2.90a	1.16abc	1.26a
50	0	7.79hi	7.77e	12.0a	11.3fg	3.20a	2.57a	1.05de	1.06de
50	100	9.29e	9.03c	12.9a	13.1cd	3.50a	2.87a	1.21ab	1.16bcd
50	200	10.8cd	10.6b	13.8a	13.5bcd	3.30a	2.90a	1.25a	1.24ab
50	300	11.1bc	10.5b	13.4a	14.2ab	3.45a	3.22a	1.23a	1.19abc
100	0	7.99gh	8.36d	13.2a	12.6de	3.27a	3.17a	0.82fg	0.93fg
100	100	10.6cd	10.6b	13.9a	13.9bc	3.22a	3.55a	0.87f	1.06de
100	200	11.6ab	11.7a	14.9a	15.0a	3.82a	3.87a	0.69h	1.10cde
100	300	11.9a	11.7a	14.7a	15.1a	3.50a	3.77a	0.77gh	0.91fg
200	0	7.46hi	7.31e	11.9a	12.5dc	3.42a	3.32a	0.98c	1.00ef
200	100	8.62f	10.4b	12.9a	13.9bc	3.47a	3.17a	1.10cd	1.08de
200	200	8.55fg	10.4b	13.4a	13.3bcd	3.60a	3.77a	0.76gh	0.80h
200	300	10.7cd	10.3b	13.9a	13.6bc	3.32a	3.80a	0.98e	0.84gh

Means having same alphabetical letter(s) within each column did not significantly differ according to Duncan's multiple range test at 5% level.

Second Experiment: Residual Effect of Nitrogen, Potassium and Their Interaction Treatments on Vegetative Growth, Flowering and Leaf Chemical Analyses

Vegetative growth and flowering

Residual effect of nitrogen fertilization

Effects of N were extended to vegetative growth and flowering of the next year. Since, replanted treated round bulbs with any used N level; *i.e.*, 50, 100 or 200 ppm resulted in significant increases in produced leaves No/ plant comparing to control. While, plant growth as leaf length (cm) was significantly enhanced in plants resulted from bulbs which previously treated with N at 100 ppm as compare to the other tested N levels during the two growing seasons (Table, 3). As previously mentioned, N at 100 ppm increased round bulb growth as dry weight and circumference (Table, 1). This in turn might reflect as more storage metabolic substances for more growth. Dana and Lerner (2001) stated that high nitrogen levels promote excessive narcissi leaf growth.

As for flowering, data of the same data in Table 3 indicate that the moderate N level (100 ppm) had the superior enhancing residual effect on flowering expressed as: flowering stalk length (cm), produced florets No/ plant and flowering plant longevity (days) comparing to control (unfertilized plants) and low (50 ppm) or high (200 ppm) N levels. However, the enhancing effect of moderate N level on flowering might be expect as a result of its enhancing effect on plant growth as leaf length which may resulted more photosynthetic and metabolic substances direction to flowering processes.

Residual effect of potassium fertilization

Results of Table 3 clear that, generally, the high two K levels of 200 and 300 ppm had the highest enhancing residual effect on growth and flowering (leaves No/ plant, leaf length, flowering stalk length, florets No/ plant and flowering plant longevity) comparing to 0 or 100 ppm K levels during the two growing seasons. There were no significant differences between 200 and 300 ppm K levels in most cases. According to Groth (2004) the period after paperwhite narcissus blooms fade is a crucial time for adding bulb food (high in potassium) to the ground around bulbs for next year's performance. Also, Nagaich *et al.* (1999) reported that fertilization onion plant with 80 Kg K_2O/ *ha* significantly increased plant dry weight.

Table 3. Growth and flowering of paperwhite narcissus as affected by residual effect of nitrogen and potassium under sandy soil conditions during 2004/ 05 and 2005/ 06 seasons

Treatments	Leaves No/ plant		Leaf length (cm)		Flowering stalk length (cm)		Florets No/ plant		Plant longevity (days)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Nitrogen levels (ppm)										
0	5.65b	5.38b	35.6c	33.1d	49.5b	36.8d	5.68d	5.77c	12.6c	13.3c
50	6.42a	6.04a	38.8b	36.3c	46.9c	45.9c	6.36c	6.43b	12.7c	13.8b
100	6.76a	6.46a	45.0a	43.0a	56.6a	55.2a	7.58a	7.24a	14.5a	14.7a
200	6.40a	6.44a	37.0c	38.3b	51.0b	49.3b	7.08b	6.59b	13.3b	14.5a
Potassium levels (ppm)										
0	5.53c	5.57b	33.0d	31.8c	44.7c	42.1c	5.44d	5.38c	12.6c	13.4c
100	5.98b	5.98ab	38.2c	36.9b	50.3b	46.0b	6.38c	6.10b	13.2b	13.8b
200	6.74a	6.52a	40.9b	40.4a	55.3a	48.8a	7.20b	7.13a	13.6a	14.4a
300	7.00a	6.25a	44.2a	41.6a	53.7a	50.2a	7.69a	7.43a	13.7a	14.6a

Means having same alphabetical letter(s) within each column did not significantly differ according to Duncan's multiple range test at 5% level.

Residual effect of interaction treatments

Data represented residual effect of interaction treatments between N and K levels on vegetative growth and flowering of paperwhite narcissus are in Table 4. Generally, the interaction treatments between moderate N level (100 ppm) and moderate (200 ppm) or high (300 ppm) K levels which resulted the heaviest bulb dry weight and the greatest bulb circumference (as previously mentioned in Table 2) also produced plants recorded the highest growth (leaf length) and flowering (flowering stalk length, florets No/ plant and flowering plant longevity) during the two residual effect growing tested seasons as compare to the all other interaction treatments. Produced leaves No/ plant was not significantly affected by interaction treatment.

Table 4. Growth and flowering of paperwhite narcissus as affected by residual effect of interaction treatments between nitrogen and potassium levels under sandy soil conditions during 2004/ 05 and 2005/ 06 seasons

Interaction treatments		Leaves No/ plant		Leaf length (cm)		Flowering stalk length (cm)		Florets No/ plant		Plant longevity (days)	
N ppm	K ppm	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	0	4.79a	5.25a	31.2g	28.6g	42.0gh	32.7f	4.77g	4.61a	11.7i	12.2f
0	100	5.43a	4.84a	35.3f	31.9fg	49.9ef	34.3f	5.24fg	5.13a	12.4ghi	13.1e
0	200	6.25a	6.04a	36.6ef	34.6ef	50.3ef	39.7e	6.02def	6.25a	12.6fgh	13.9d
0	300	6.15a	5.39a	39.4de	37.5de	55.7bcd	40.5e	6.67cde	6.68a	13.5cde	14.0cd
50	0	5.63a	4.86a	34.5f	31.0fg	39.0h	37.0ef	4.96g	5.10a	12.1hi	13.0e
50	100	5.81a	6.07a	37.8def	33.9ef	44.9fg	48.4cd	5.91ef	6.67a	12.6fgh	14.0d
50	200	6.74a	6.67a	39.1de	39.5cd	52.3cde	48.9cd	6.77cd	6.92a	13.0defg	14.3cd
50	300	7.51a	6.54a	43.8c	40.7cd	51.4de	49.3cd	7.82ab	7.02a	13.5cde	14.4cd
100	0	5.97a	6.25a	37.7def	35.1ef	49.6ef	53.2abc	6.75cd	6.48a	13.6cd	14 3cd
100	100	6.44a	6.17a	41.0cd	40.6cd	56.6a-d	54.6ab	7.20bc	6.36a	14.5ab	14.4cd
100	200	7.21a	7.01a	48.5b	50.1a	61.7a	57.0a	8.26a	7.88a	14.9ab	15.2a
100	300	7.44a	6.44a	52.6a	46.1b	58.6ab	56.1a	8.14a	8.25a	15.1a	15.0ab
200	0	5.73a	5.94a	28.6g	32.6f	48.1ef	45.4d	5.28fg	5.32a	13.1defg	14.3cd
200	100	6.23a	6.84a	38.9de	41.1cd	50.0ef	46.7d	7.16bc	6.24a	13.3cdef	14.1cd
200	200	6.77a	6.36a	39.4de	37.5de	56.9abc	49.9bcd	7.75ab	7.06a	14.2bc	14.6bc
200	300	6.89a	6.63a	41.0cd	42.0c	49.2ef	55.1a	8.14a	7.76a	12.7efgh	15.1ab

Means having same alphabetical letter(s) within each column did not significantly differ according to Duncan's multiple range test at 5% level.

Leaf Chemical Analyses

Generally, as used nitrogen level was increased up to 200 ppm leaf percentages of N, P, K and total carbohydrates increased in plants resulted from replanting round bulbs (Table 5). Koriem (1987) found that N- bulb and foliage contents of onion plant were significantly increased by increasing N fertilization up to 90 Kg/ *fed.*, while K- bulb and foliage were not affected by N applications.

The same Table 5 shows that K treatments especially at 200 and 300 ppm significantly increased leaf contents of K, N and total carbohydrates as percentages. Phosphorus % did not significantly affect by K treatments during the two residual effect growing seasons.

Table 5. Leaf chemical constituents of paperwhite narcissus as affected by residual effect of nitrogen and potassium under sandy soil conditions during 2004/ 05 and 2005/ 06 seasons

Treatments	N %		P %		K %		Total carbohydrates %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Nitrogen levels (ppm)								
0	2.86c	3.10b	0.31ab	0.31a	3.36a	3.22c	15.8d	17.0d
50	2.85c	3.17b	0.30b	0.31a	3.39a	3.48b	16.5c	18.1c
100	3.82b	3.85a	0.34a	0.33a	3.48a	3.73a	20.2b	22.8a
200	4.06a	3.98a	0.33a	0.32a	3.50a	3.58ab	21.9a	19.2b
Potassium levels (ppm)								
0	3.24b	3.45a	0.32a	0.31a	2.76c	2.96d	14.4d	16.6d
100	3.27b	3.49a	0.31a	0.31a	3.25b	3.29c	17.8c	17.5c
200	3.47ab	3.53a	0.32a	0.33a	3.76a	3.75b	20.5b	20.8b
300	3.60a	3.61a	0.33a	0.32a	3.95a	4.01a	21.7a	22.2a

Means having same alphabetical letter(s) within each column did not significantly differ according to Duncan's multiple range test at 5% level.

Residual effects of interaction treatments on leaf chemical analysis are presented in Table 6. Results indicate that each nitrogen and potassium levels acted separately on P and K percentages in plant leaf tissues during the two tested seasons. While, N and total carbohydrates percentages were significantly increased under the interaction treatments residual effects of N at 100 ppm interacted with K at 200 or 300 ppm comparing with the most of other interaction treatments. Ibraheim (2004) recorded significant increases in total uptake of N, P and K in onion plants subjected to fertilization of N interacted with K at level of 100 Kg N + 125 Kg K_2O/*fed.*

Correlation Study

Interrelationships between bulb characters and leaf chemical analysis

Data in Table 7 illustrate that round bulb dry weight on one hand correlated positively and significantly or highly significantly with N, K and total carbohydrates percentages in plant leaf tissues under K treatments effect and with K and total carbohydrates percentages under interaction treatments effect on the other hand. This implicates that under K treatments effect N, K and total carbohydrates while under interaction treatments effect only K and total carbohydrates contribute in enhancing bulb dry weight, and in turn reflected as more supplying of these constituents in leaves of produced plants. Respecting the second interrelationship between round bulb circumference and percentages of the studied chemical constituents in plant leaf tissues, data of the same Table 7 show that P, K and total carbohydrates percentages under N treatments effect; K and total carbohydrates percentages under K treatments effect; and the all studied chemical constituents (N, P, K and carbohydrates) under the interaction between N and K treatments effect were associated positively and significant or high significant with round bulb circumference. So, under the main or interaction treatments effect of N and K bulb circumference grow was might be due to increasing these chemical constituents in produced bulbs and this reflected as more percentages of these elements in leaf tissues. These results support the concept of treatments which increased bulb growth (dry weight or circumference) also increased supplying the produced plants from these bulbs with N, P, K and or total carbohydrates.

Table 6. Leaf chemical constituents of paperwhite narcissus as affected by residual effect of interaction treatments between nitrogen and potassium levels under sandy soil conditions during 2004/ 05 and 2005/ 06 seasons

Interaction treatments		N %		P %		K %		Total carbohydrates %	
N levels ppm	K levels ppm	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	0	2.76ef	3.02c	0.30a	0.31a	2.41a	2.72a	11.9g	15.2h
0	100	2.59ef	3.30bc	0.32a	0.30a	3.24a	2.98a	15.4f	16.4gh
0	200	3.08de	3.13bc	0.29a	0.32a	3.76a	3.17a	17.2e	17.6efg
0	300	3.00def	2.94c	0.32a	0.31a	4.01a	4.01a	18.8cd	19.0cde
50	0	2.51f	2.83c	0.31a	0.32a	2.80a	2.94a	11.9g	16.0gh
50	100	2.97ef	3.01c	0.27a	0.31a	3.04a	3.17a	16.0f	17.2fg
50	200	2.83ef	3.15bc	0.28a	0.31a	3.70a	3.93a	18.2d	18.9cde
50	300	3.08de	3.69ab	0.32a	0.30a	4.01a	3.87a	19.8c	20.1c
100	0	3.52cd	3.97a	0.33a	0.32a	2.87a	3.06a	15.2f	18.2def
100	100	3.69bc	3.68ab	0.32a	0.32a	3.27a	3.62a	17.1e	19.1cde
100	200	4.07ab	3.90a	0.34a	0.33a	3.86a	4.15a	23.3b	27.2a
100	300	3.99abc	3.86a	0.35a	0.33a	3.92a	4.11a	25.3a	26.6a
200	0	4.18ab	4.01a	0.32a	0.30a	2.95a	3.12a	18.4d	17.1fg
200	100	3.85abc	3.98a	0.31a	0.33a	3.45a	3.42a	22.7b	17.2fg
200	200	3.88abc	3.96a	0.33a	0.34a	3.73a	3.74a	23.3b	19.7cd
200	300	4.34a	3.97a	0.33a	0.32a	3.87a	4.05a	23.2b	23.0b

Means having same alphabetical letter(s) within each column did not significantly differ according to Duncan's multiple range test at 5% leve

Table 7. Simple correlation coefficients between some characteristics of round bulbs and leaf chemical analysis of paperwhite narcissus plants obtained from replanted the fertilized bulbs (pooled data of 2003/ 04 and 2004/ 05 for bulb characters and of 2004/ 05 and 2005/ 06 for chemical analyses)

The character	N %	P %	K %	Total carbohydrates %
Under N treatments effect				
Round bulb dry weight (g)	0.332	0.482	0.590	0.471
Round bulb circumference (cm)	0.650	0.728*	0.828*	0.726*
Under K treatments effect				
Round bulb dry weight (g)	0.762*	0.594	0.955**	0.930**
Round bulb circumference (cm)	0.670	0.548	0.947**	0.904**
Under interaction treatments effect (N x K)				
Round bulb dry weight (g)	0.302	0.332	0.846**	0.694**
Round bulb circumference (cm)	0.522**	0.370*	0.811**	0.759**

N = 8 for N treatments, 8 for K treatments and 32 for interaction treatments

Interrelationships between leaf chemical analysis and plant growth and flowering

Simple correlation coefficients between leaf chemical analysis of paperwhite narcissus and its growth and flowering aspects under the effect of N, K and their interaction treatments are shown in Table 8.

Under the main effect of N treatments, the results reflect positive and significant or high significant relationship between plant vegetative growth (as leaf production/ plant) and leaf contents of N, P and total carbohydrates. Regarding flowering, the positive and significant relations were recorded for florets production/ plant and leaf contents (percentages) of N, P, K and carbohydrates, flowering stalk length and leaf percentages of P and K, as well as flowering longevity and percentages of N, K and total carbohydrates in plant leaves.

Under the main effect of K treatments, each of vegetative growth (as leaf No/ plant and leaf length) and percentages of K and carbohydrates in plant leaves affected positively and significantly on the other. N, K and carbohydrates percentages positively and significantly correlated with

flowering aspects of florets production/ plant and flowering plant longevity. Flowering stalk length also correlated positively significantly with K and carbohydrate percentages.

Under interaction between N and K treatments effect, all studied growth and flowering parameters associated positive and significant or high significant with the all investigated leaf chemical constituents. This was predicted, since the interaction treatment which enhanced produced bulb growth also increased percentages of chemical contents in resulted plant (Table 7) and subsequently encouraged plant vegetative growth and flowering.

Table 8. Simple correlation coefficients between leaf chemical analyses of paperwhite narcissus and its growth and flowering aspects under the effect of N, K and their interaction treatments (pooled data of 2004/ 05 and 2005/ 06 seasons)

The character	Vegetative growth aspects		Flowering aspects		
	Leaves No/ plant	Leaf length (cm)	Flowering stalk length (cm)	Florets No/ plant	Flowering longevity (days)
Under N treatments effect					
N %	0.848**	0.512	0.578	0.790*	0.744*
P %	0.860**	0.694	0.726*	0.850**	0.698
K %	0.631	0.670	0.752*	0.714*	0.734*
Total carbohydrates (%)	0.724*	0.597	0.633	0.845**	0.709*
Under K treatments effect					
N %	0.656	0.653	0.363	0.710*	0.847**
P %	0.704	0.641	0.497	0.677	0.364
K %	0.886**	0.947**	0.786*	0.979**	0.787*
Total carbohydrates (%)	0.863**	0.918**	0.749*	0.961**	0.806*
Under interaction treatments effect (N x K)					
N %	0.538**	0.424*	0.523**	0.560**	0.642**
P %	0.418**	0.472**	0.432*	0.504**	0.546**
K %	0.734**	0.775**	0.647**	0.815**	0.632**
Total carbohydrates %	0.700*	0.775**	0.670**	0.855**	0.717**

N = 8 for N treatments, 8 for K treatments and 32 for interaction treatments

CONCLUSION

From the previously mentioned results, it could be concluded that fertilization paperwhite narcissus with solution containing 100 ppm N combined with 200 ppm K, as weekly doses in 200 cc/ pot for each, significantly improved round bulb characteristics (dry weight and circumference), and consequently enhanced flowering (flowering stalk length, florets No/ plant and flowering plant longevity) of plants resulted from replanting these fertilized round bulbs in the next year.

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استجابة نبات النرجس لمستويات التسميد النيتروجينى والبوتاسى تحت ظروف الأرض الرملية

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أجري هذا البحث في تجربتين على نباتات النرجس الأبيض تحت ظروف الأرض الرملية في المزرعة التجريبية لمعهد الكفاية الإنتاجية، جامعة الزقازيق. نفذت التجربة الأولى خلال الموسمين المتتاليين ٢٠٠٣/ ٢٠٠٤، ٢٠٠٤/ /٢٠٠٥ بهدف دراسة تأثير التسميد بأربع مستويات من النيتروجين (صفر، ٥٠ ، ١٠٠ ، ٢٠٠ جزء في المليون) وأربع مستويات من للبوتاسيوم (صفر ، ١٠٠ ، ٢٠٠ ، ٣٠٠ جزء في المليون) ، كجرعات أسبوعية في ٢٠٠ سم^3 محلول لكل أصيص ، وتفاعلاتهم على خصائص الأبصال المستديرة والمشطوفة الناتجة ، بينما أجريت التجربة الثانية في مواسم ٢٠٠٤/٢٠٠٥ ، ٢٠٠٥/ ٢٠٠٦ بهدف تقييم التأثير المتبقي لمعاملات التسميد سابقة الذكر على النمو الخضري والإزهار والتحليل الكيميائي للنباتات الناتجة من إعادة زراعة الأبصال المستديرة المسمدة سابقا والناتجة من التجربة الأولى.

أدى التسميد النيتروجينى بتركيز ١٠٠ جزء في المليون أو البوتاسى بتركيز ٢٠٠ جزء في المليون ، كل بمفرده ، إلى زيادة معنوية في المحيط والوزن الجاف للبصلة المستديرة ، زاد عدد الأبصال المشطوفة الناتجة من كل نبات بالتسميد النيتروجينى بتركيز ١٠٠ جزء في المليون ، بينما أدى البوتاسيوم بتركيز ٢٠٠ جزء في المليون إلى زيادة الوزن الجاف للبصلة المشطوفة ، أدى تفاعل ١٠٠ جزء في المليون نيتروجين مع ٢٠٠ جزء في المليون بوتاسيوم إلى زيادة الوزن الجاف والمحيط للبصلة المستديرة. علاوة على ذلك ، كان لنفس معاملة التفاعل الأثر المتبقي المنشط الأكبر على خصائص الإزهار (طول الحامل الزهري ، عدد الزهيرات / نبات ، فترة بقاء النبات المزهر) علاوة على زيادة النسبة المئوية للنيتروجين بأنسجة أوراق النباتات الناتجة من إعادة زراعة الأبصال المستديرة المسمدة سابقاً مقارنةً بباقي معاملات التفاعل الأخرى.

أظهرت علاقات الارتباط تحت تأثير معاملات التفاعل بين النيتروجين والبوتاسيوم وجود علاقات معنوية موجبة بين محيط البصلة المستخدمة في الزراعة وبين المكونات الكيميائية (ن، فو ، بو ، الكربوهيدرات الكلية) لأنسجة أوراق النبات الناتج منها ، وكذلك بين المكونات الكيميائية بالأوراق وبين خصائص النمو والإزهار.