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Gibberellin Inhibitor Treatments Before Planting Control Plant Height of *Narcissus tazetta* by Affecting Growth Parameters

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ABSTRACT
The effects of flurprimidol and paclobutrazol, treatments as preplant bulb soaks on plant height, growth parameters and other properties of *Narcissus tazetta* L. grown in pots were investigated. Bulbs were soaked in flurprimidol at 0, 10, 20 mg L^{-1} or paclobutrazol at 0, 100, 200 mg L^{-1} before planting. The effects of gibberellin inhibitors on the flower number, flowering time, flower life, plant height, leaf length and quantitative measurements (specific leaf area, leaf area ratio, leaf thickness, leaf weight ratio and stem weight ratio) were determined. When narcissus reached to the sale stage, plants were taken to the laboratory where the temperature stable at 20°C to evaluate the postproduction quality. The shortest plant height (6.25 cm, 63% shorter than control) was obtained from the 20 mg L^{-1} flurprimidol application. Plants applied with 200 mg L^{-1} paclobutrazol were 59% shorter than control with 7.00 cm plant height. Gibberellin inhibitors also shortened the leaf length and increased the leaf thickness, whereas decreased leaf area ratio and specific leaf area by shortening the plant height. The effects of gibberellin inhibitors on plant height continued after harvest (production) in marketing and consumer (laboratory) conditions. The plant heights of treated plants were 10.87 (20 mg L^{-1} flurpirmidol) and 10.37 (200 mg L^{-1} paclobutrazol) cm, while with the control plants were 26.75 cm in with laboratory conditions.

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Narcissus tazetta Soğanlarına Dikim Öncesi Uygulanan Gibberellin İnhibitörlerinin Büyüme Parametreleri ve Bitki Boyu Üzerine Etkileri

ÖZET
Dikim öncesi soğanlara uygulanan gibberellin inhibitörleri flurprimidol ve paclobutrazolün serada saksıda yetiştirilen *Narcissus tazetta* L. türünde bitki boyu, büyüme parametreleri ve bazı kalite özellikleri üzerine olan etkileri incelenmiştir. Dikim öncesi soğanlara 0, 10, 20 mg L^{-1} dozlarında flurpimidol ve 0, 100, 200 mg L^{-1} dozlarında paclobutrazol uygulanmıştır. Gibberellin inhibitörlerinin çiçek sayısı, çiçek ömrü, bitki ve yaprak boyu üzerine etkileri belirlenmiştir. Ayrıca oransal yaprak alanı, özgül yaprak alanı, yaprak kalınlığı, oransal yaprak ağırılığı ve oransal gövde ağırlığı kantitatif analizler ile saptanmıştır. Satış aşamasına gelen nergisler üretim sonrası kalitenin incelenmesi amacıyla sıcaklığı 20°C'de sabit tutulan laboratuvar ortamına alınmıştır. En kısa bitki boyu 6.25 cm ile 20 mg L^{-1} flurprimidol uygulamasından elde edilmiş, bu uygulama bitki boyunu kontrole göre %63 kısaltmıştır. 200 mg L^{-1} paclobutrazol uygulamasından 7.00 cm bitki boyu elde edilmiş, bu bitkiler kontrole göre %59 daha kısa olmuştur. Gibberellin inhibitör uygulamaları yaprak boyunu da kısaltmıştır. Uygulamalar bitki boyunu kısaltarak yaprak kalınlığını artırmış, oransal yaprak alanı ile özgül yaprak alanını azaltmıştır. İnhibitörlerin bitki boyu üzerine olan etkisi üretim sonrasında da devam etmiştir. Laboratuvar koşullarında 20 mg L^{-1} flurpirmidol ve 200 mg L^{-1} paclobutrazol uygulamalarından sırasıyla 10.87 ve 10.37, kontrolden ise 26.75 cm bitki boyu elde edilmiştir.

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INTRODUCTION

Narcissus tazetta is a herbaceous and perennial plant belonging to family of Amaryllidaceae (Li et al., 2012; Alp et al., 2015). This species with numerous fragrant flowers in a stem is naturally grown in Turkey including the black sea region (Kebeli and Çelikel, 2013). *N. tazetta* L. has rich alkaloids used in cosmetics and medical industries (Cimmino et al., 2017). The narcissus is also used as cut flower due to the flowers with long stems, as well as in refuges, gardens and parks as outdoor ornamental plants. *Narcissus* is also used as a potted indoor plant. But excessive elongation of them at consumer conditions because of the lower light makes them difficult to use indoor (Çelikel et al., 2016). Elongation causes also flower stem bending. The control of plant height is important to prevent damage during both transportation and marketing due to stem elongation as well as maintaining compactness and aesthetically pleasing appearance (Çelikel et al., 2016). It is important to know the growing techniques of indoor plants such as plant height control especially in bulbous flowers (Çelikel, 2015). Plant height may be controlled by physical or chemical methods with plant growth retardants mostly gibberellin inhibitors (Çelikel et al., 2016; Demir and Çelikel, 2019).

Bulb soaks of flurprimidol at 30 mg L^{-1} has controlled the height of narcissus cultivars (Miller 2013). Preplant bulb soak treatments of paclobutrazol at concentration 30 mg L^{-1} controlled the height of iris cultivars during greenhouse period (Demir and Çelikel, 2018a). Plant height of 'Ice Follies' narcissus cv. was controlled by bulb soaks of paclobutrazol and flurprimidol in the post-production period (Demir and Çelikel, 2018b). Ahmad Nazarudin et al. (2007), reported that paclobutrazol treatments caused the control of plant height by decreasing the leaf area and leaf expansion.

Demir and Çelikel (2019) used gibberellin inhibitors as soil drench to investigate the plant height control of *Narcissus tazetta* grown naturally in Black Sea Region of Turkey. However, there is no previous study on bulb soak treatments of inhibitors in this species. Therefore, the effects of inhibitor treatments as preplant bulb soaks on plant height, growth parameters and different properties of native *Narcissus tazetta* L. grown in pots were investigated in this study.

MATERIAL and METHODS

Plant and Chemical Material

Narcissus tazetta L . bulbs (circumference: 12 cm) from Ordu province of Turkey were used in this study. Paclobutrazol (25% Cultar, Syngenta) and flurprimidol (Sigma-Aldrich) were used as gibberellin inhibitors. Paclobutrazol (PBZ) and flurprimidol (FP) block cytochrome P450-dependent monooxygenases, thereby inhibiting gibberellin (GA) biosynthesis (Rademacher, 2000; Verma et al., 2010).

Treatments

Bulbs were soaked into FP solutions of 0, 10, 20 mg L^{-1} or PBZ of 0, 100, 200 mg L^{-1} for 30 min before planting. Ethanol (2%) was also used as a control, solvent of FP. Bulbs of narcissus were allowed to air dry, then planted into plastic pots with volume of 1.6 L, containing equal perlite, peat and soil, as one bulb for each pot on the treatment day (7 October). A polyethylene greenhouse was used for the growth of plants and they were irrigated with tap water.

Measurements and observations

Flowering time, number of flowers and flower life: Time of flowering was counted as day's number from planting to opening of the first flower. Flower numbers were determined per stem of narcissus. Day's number from the opening of the first flower to the wilting of the last flower was determined as flower life.

Plant height and leaf length: The leaf length (longest leaf) and plant height (from the pot surface to the uppermost of the inflorescence) were started to measure weekly respectively 21 (28 October) and 91 days (6 January) after planting.

Quantitative measurements: Whole plants were removed from the pot, after flowers wilted for the quantitative analysis. Quantitative measurements used in this study were as follows:

Leaf area: Leaf areas were measured with a planimeter (Koizumi Placom) by taking photocopies of leaves on the paper.

Dry weights: The plants as a whole with foliage and roots were removed from the pot. Leaves were separated and used for area measurement first. Then all samples (roots, leaves and stems (bulbs) were dried in an oven ('Ecocell') at 80 °C for 72 hours to determine growth parameters. Dry weights of plant samples were determined immediately after drying. Calculation formulas: Calculation formulas of quantitative parameters described by Uzun (1996) for vegetables were adapted to the bulbous plants (Demir and Çelikel 2019) to calculate the plant growth parameters for *Narcissus tazetta*. The whole bulbs were used as stem for bulbous *Narcissus tazetta* plants. Specific leaf area (SLA), leaf area ratio (LAR), leaf thickness (LT), leaf weight ratio (LWR) and stem (bulb) weight ratio (SWR) were determined as quantitative parameters.

Postproduction evaluation

When narcissus reached to the harvest (sales) stage (Demir and Çelikel, 2019), four replicate plants randomly selected from each treatment were taken to the laboratory on 14 February. Postproduction quality of pot plants was evaluated in the laboratory at 20 °C, under cool white fluorescent light of 1000 lux and a diurnal cycle of 12 h day/12 h night as standard conditions described by Çelikel (1993) and Çelikel et al. (2011).

Data Analysis

The study was carried out with ten replications except four replications for postproduction evaluation and three replications for quantitative analyses. Data were tested by ANOVA according to a completely randomized design. Data were analyzed using the SPSS package program. Differences among the means of applications were determined by Duncan's multiple range tests (P≤0.01).

RESULTS and DISCUSSION

Flowering time, number of flowers and flower life

Narcissus is one of the most important bulbous ornamental plants. It is necessary to inhibit the excessive elongation of narcissus grown in pots (Çelikel et al., 2016). Plant growth regulators are used to reduce unwanted longitudinal shoot growth (Rademacher, 2000). We used PBZ and FP to control the plant height in native narcissus to grow as indoor plant. The effects of gibberellin inhibitor applications on the flowering time of narcissus are given in Table 1. According to treatments, the earliest flowering was in control and ethanol with 108 and 111 days, respectively. A clear difference was between control and the treatments of 20 mg L^{-1} FP (119 days) as well as 200 mg L^{-1} PBZ (119 days) (Table 1). FP at 25 mg L^{-1} delayed the flowering time about 3 days in tulips (Krug et al., 2005). In another study, PBZ as preplant bulb soaks delayed the time to appearance of buds in 'Frans Hals' and 'Blue Magic' iris cultivars (Demir and Çelikel, 2018a). In the present study the gibberellin inhibitors similarly delayed the time of flowering in narcissus about 8-11 days and effect of gibberellin inhibitors on flowering time increased depending on concentration. It has been stated that gibberellin has a role in the flowering control (Blázquez et al., 1998), promoted the flower initiation and development in several species (Su et al., 2001).

The numbers of flowers were affected by gibberellin inhibitors in this study. The difference between control and treated plants was significant (P≤0.01) (Table 1). Numbers of flowers were 5.88 (10 mg L^{-1} FP), 5.84 (20 mg L^{-1} FP), 6.17 (100 mg L^{-1} PBZ) and 6.00 (200 mg L^{-1} PBZ), while control plants and ethanol treatments were 7.6 and 7.0 (Table 1). The number of flowers in *Chrysanthemum* was decreased by gibberellin inhibitor of Pro-Ca and daminozide (Kim et al., 2010). Gibberellin played a role in the flowering (Blázquez et al., 1998). Therefore, the PBZ and FP used in this study probably affected the numbers of flowers.

According to statistical analysis the effect of treatment on flower life was not found significant (P>0.05) (Table 1). The flower life varied between 2-3 weeks in *N. tazetta* (Acarsoy and Özzambak, 2006). In this study, the flower life was similarly 15-16 days.

Table 1. Effects of PBZ and FP on the flowering time, number of flowers and flower life of *Narcissus tazetta* L. Mean ± SE

Çizelge 1. PBZ ve FP'nin Narcissus tazetta'da çiçeklenme zamanı, çiçek sayısı ömrü üzerine etkileri Ortalama ± SH

Treatments	Flowering time (days)	Numbers of flowers	Flower life (days)
Control	108.80 ± 1.36 b	7.60 ± 0.98 a	16.20 ± 0.20
Ethanol	111.00 ± 1.55 b	7.00 ± 0.73 a	15.17 ± 0.70
100 mg L^{-1} PBZ	116.17 ± 2.29 ab	6.17 ± 0.79 b	16.33 ± 0.60
200 mg L^{-1} PBZ	119.83 ± 1.10 a	6.00 ± 0.63 b	16.17 ± 0.80
10 mg L^{-1} FP	116.63 ± 2.13 ab	5.88 ± 0.17 b	15.38 ± 0.50
20 mg L^{-1} FP	119.38 ± 1.83 a	5.84 ± 0.48 b	15.17 ± 1.30
Sig.	0.001	0.009	0.782 *

Values within a column with different letters differ significantly at P≤0.01 SE: Standard Error, *Not Significant

Plant height and leaf length

The gibberellin inhibitors had a significant effect (P≤0.01) in reducing plant height. The shortest plant height was measured as 6.25, 7.0 and 8.33 cm from the plants which were applied 20 mg L^{-1} FP, 200 mg L^{-1} PBZ and 100 mg L^{-1} PBZ, respectively, whereas the control and ethanol were 16.9 and 17.7 cm, respectively (Figure 1, Table 2). Preplant bulb soaks with gibberellin inhibitor paclobutrazol, flurprimidol and uniconazole shortened the plant height of 'Prominece' tulips (Krug et al., 2005). A treatment of 25 mg L^{-1} flurprimidol as preplant bulb soak significantly controlled the plant height of 'Dutch Master' narcissus cultivars during greenhouse production (Krug et al., 2006). Similarly, application of PBZ and FP shortened the plant heights in plumbago (Barker et al., 2016). Applications of gibberellin inhibitor Pro-Ca at 100, 200 and 400 mg L^{-1} suppressed the plant height in *Chrysanthemum morifolium* by 8.2, 20.9 and 26.3%

respectively (Kim et al., 2010). In this study PBZ and FP similarly reduced the plant height of *Narcissus*. These plants were 63% (20 mg L^{-1} FP), 59% (200 mg L^{-1} PBZ) and 51% (100 mg L^{-1} PBZ) shorter than untreated control (Table 2). In a previous study, narcissus applied with 2 mg/pot PBZ as soil drench were 65% shorter than control ones (Demir and Çelikel, 2019). Yeshitela et al. (2004) reported that PBZ suppressed the vegetative growth of *Mangifera indica.* According to Banon et al. (2002) PBZ could be used to control the growth of 'Mondriaan' carnation and improve its commercially quality.

Treatments reduced the length of leaf in narcissus. The shortest leaf length (11.85 and 12.75 cm) was measured from 200 mg L^{-1} PBZ and 20 mg L^{-1} FP respectively and these treatments followed by the untreated control and ethanol application (21 and 24 cm, respectively, Table 2). FP treatment caused to shorter leaves in *Zantedeschia aethiopica* (Gonzalez et al., 1999). The treatments of PBZ and FP also shortened the leaf length of *N. tazetta* (Table 2), similar to the previous study.

Table 2. Effects of PBZ and FP on the plant height and leaf length of *Narcissus tazetta* L. at the end of the growing period. Mean ± SE

Çizelge 2. PBZ ve FP'nin Narcissus tazetta'da bitki ve yaprak boyu üzerine etkileri Ortalama ± SH

Treatments	Plant height (cm)	Leaf length (cm)
Control	16.90 ± 1.50 a	21.25 ± 1.75 a
Ethanol	17.67 ± 2.32 a	24.00 ± 0.76 a
100 mg L^{-1} PBZ	8.33 ± 1.11 c	15.20 ± 0.76 bc
200 mg L^{-1} PBZ	7.00 ± 1.18 c	11.85 ± 0.48 c
10 mg L^{-1} FP	10.44 ± 1.24 b	16.30 ± 0.71 b
20 mg L^{-1} FP	6.25 ± 0.50 c	12.75 ± 0.53 c
Sig.	0.000	0.000

Values within a column with different letters differ significantly at P≤0.01 SE: Standard Error

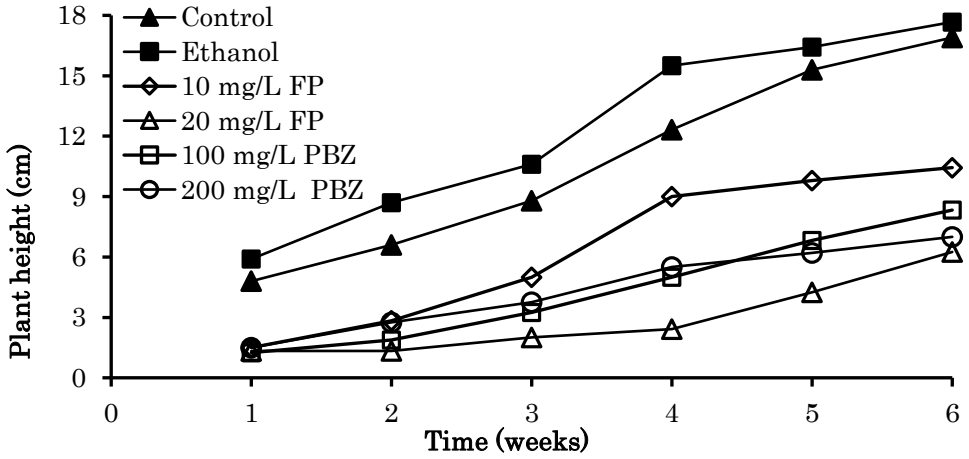

Figure 1. Effects of FP and PBZ applicatipons on the plant height of *Narcissus tazetta* L. during greenhouse forcing period. The plant height was started to measure 91 days after planting, (6 January).

Şekil 1. FP ve PBZ uygulamalarının serada üretim süresince Narcissus tazetta'da bitki boyu üzerine etkileri. Bitki boyu ölçümlerine dikimden 91 gün sonra başlanmıştır (6 Ocak).

Postproduction evaluation

Preplant bulb soaking with FP and PBZ treatments shortened the plant height of *Narcissus* compared to untreated controls (Figures 1 and 2) in this study. The height difference between untreated control and treatments also continued during post production period in lab conditions (Figures 2, 3 and 4). The plant heights of treated plants were 12.37 (10 mg L^{-1} FP), 10.87 (20 mg L^{-1} FP), 11.00 (100 mg L^{-1} PBZ) and 10.37 (200 mg L^{-1} PBZ) cm, while the ethanol and control plants were 25.37 and 26.75 cm, respectively (Figure 2). It was reported that transportation and storage can give damage to the quality of potted plants (Ferrante et al., 2015). Therefore, it's important to maintain the compactness to prevent damage during transportation and marketing. According to the results of the present study, FP and PBZ effectively controlled the plant height both during greenhouse and post production period.

The leaf lengths of treated plants were 16.0 (10 mg L^{-1} FP), 13.0 (20 mg L^{-1} FP), 14.75 (100 mg L^{-1} PBZ) and 12.25 (200 mg L^{-1} PBZ) cm, while it was 29.25 and 25 cm respectively, in the ethanol and control plants. The significant differences in terms of leaf length between plants, which were treated with gibberellin inhibitors as a soil drench, and control, were continued in the

postproduction period (Demir and Çelikel, 2019). In this study similarly the leaf length difference between untreated control and treated plants by FP and PBZ as bulb soaks was preserved in the consumer conditions, too.

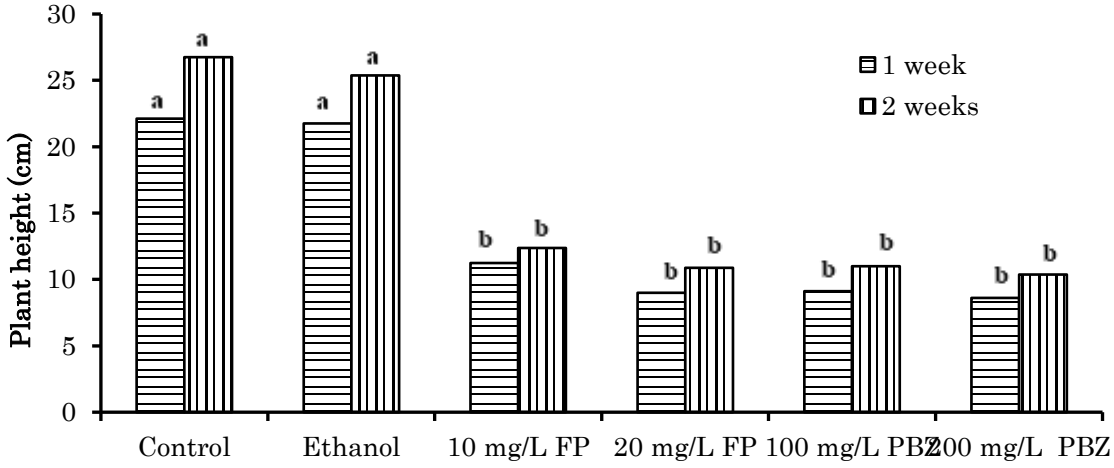

Figure 2. Effects of FP and PBZ applications on the plant height of *Narcissus tazetta* L. during post production period in laboratory conditions (1 week; 14 February).

Şekil 2. FP ve PBZ uygulamalarının üretim sonrası laboratuvar koşullarında Narcissus tazetta'da bitki boyu üzerine etkileri. (1. hafta; 14 Şubat)

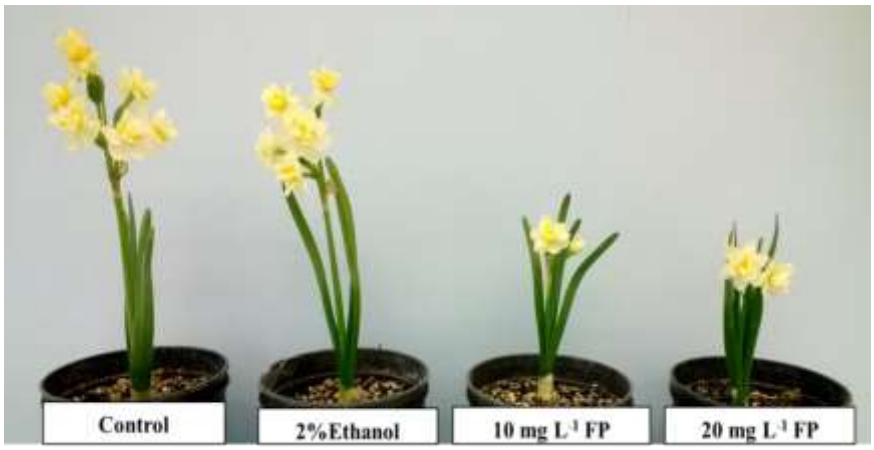

Figure 3. The effects of FP bulb soak on *Narcissus tazetta* L. (3 days at the sale stage in lab.)

Şekil 3. Soğana uygulanan FP'nin Narcissus tazetta L. üzerine etkileri (satış aşaması laboratuvarda 3. gün)

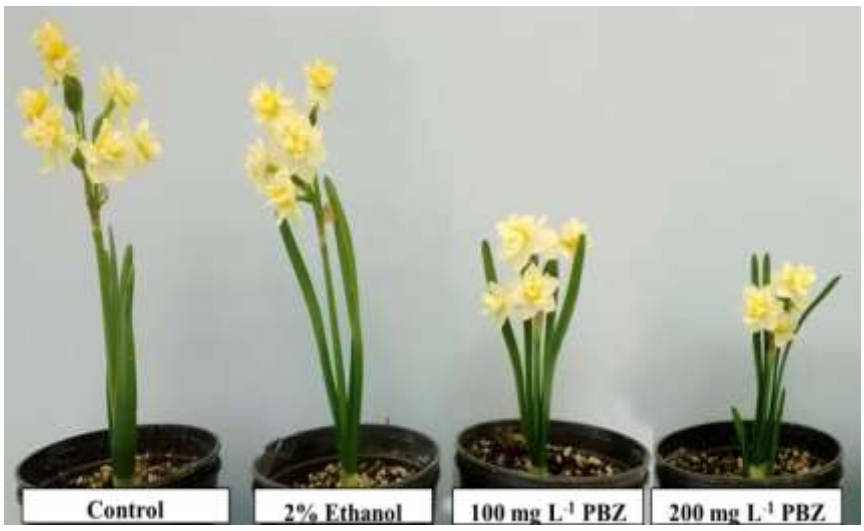

Figure 4. The effects of PBZ bulb soak on *Narcissus tazetta* L. (3 days at the sale stage in lab.)

Şekil 4. Soğana uygulanan PBZ'nin Narcissus tazetta L. üzerine etkileri (satış aşaması laboratuvarda 3. gün)

Quantitative Analysis

Leaf area ratio (LAR): PBZ and FP treatments decreased the LAR. The LAR of 10 mg L^{-1} FP, 20 mg L^{-1} FP, 100 mg L^{-1} PBZ and 200 mg L^{-1} PBZ applications were 7.51, 5.80, 7.46 and 5.95 whereas ethanol and control plants were 12.26 and 12.27 $cm^2 g^{-1}$, respectively (Table 3). Plants with gibberellin inhibitor treatments resulted with shorter appearance and smaller leaf area (Table 2, 3). As a result of increased plant compactness, LAR decreased in this study. Leaf area of *Xanthostemon chrysanthus* (Ahmad Nazarudin et al., 2015) and lantana (Matsoukis et al 2014) decreased with PBZ treatments compared to the control. The reduction in leaf area could be attributed to a reduction in cell elongation and proliferation resulted by reduced GA synthesis with PBZ treatment (Matsoukis et al., 2014). Similarly, the results showed that gibberellin inhibitors are effective to reduce the leaf area ratio of narcissus.

Table 3. Effects of PBZ and FP on the LAR, SLA and LT of *Narcissus tazetta* L. Mean ± SE
Çizelge 3. PBZ ve FP'nin Narcissus tazetta'da YAO, ÖYA ve YK üzerine etkileri Ortalama ± SH

Treatments	LAR ($cm^2 g^{-1}$)	SLA ($cm^2 g^{-1}$)	LT ($g cm^{-2}$)
Control	12.27 ± 1.19 a	128.36 ± 12.24 a	0.008 ± 0.0007 c
Ethanol	12.26 ± 1.19 a	107.44 ± 2.960 ab	0.009 ± 0.0003 c
100 mg L^{-1} PBZ	7.46 ± 0.20 b	91.76 ± 11.57ab	0.011 ± 0.0016 ab
200 mg L^{-1} PBZ	5.95 ± 0.33 b	75.70 ± 8.100 c	0.013 ± 0.0014 a
10 mg L^{-1} FP	7.51 ± 1.09 b	81.13 ± 4.290 bc	0.012 ± 0.0007 ab
20 mg L^{-1} FP	5.80 ± 0.67 b	71.48 ± 4.700 c	0.014 ± 0.0100 a
Sig.	0.000	0.003	0.006

Values within a column with different letters differ significantly at P≤0.01 SE: Standard Error, LAR: Leaf area ratio, SLA: Spesific leaf area, LT: Leaf Thickness

Specific leaf area (SLA): Differences among the treatments were statistically significant (P≤0.01). The lowest SLAs were 71.48 and 75.70 $cm^2 g^{-1}$ from 20 mg L^{-1} FP and 200 mg L^{-1} PBZ, while the control was 128.36 $cm^2 g^{-1}$ (Table 3). *Narcissus* applied with gibberellin inhibitors were more compact and smaller SLA than the control. It was reported that the SLA of lantanas applied with PBZ (80 mg L^{-1}) was lower compared to control (Matsoukis et al., 2014). Uniconazole decreased SLA of Logan (Nie et al., 2001). Uniconazole is one of gibberellin inhibitors, act by inhibiting gibberellin biosynthesis (Rademacher, 2000).

Leaf thickness (LT): FP and PBZ increased the LT (P≤0.01). The highests leaf thickness were 0.014 and 0.013 g cm^{-2} from 20 mg L^{-1} FP and 200 mg L^{-1} PBZ, respectively, while the untreated control was 0.008 g cm^{-2} and plants treated with ethanol was 0.009 g cm^{-2} (Table 3). These results showed that there was an increase of the leaves dry weight in the unit area and plants applied FP and PBZ had a thicker and compact structure (Table 3). This increase is probably because of the increase in dry mass per unit area as a result of an increase in the amount of chlorophyll in the unit area. The relative chlorophyll content of the leaves in *Ornithogalum saundersiae* applied with flurprimidol was higher compared to control plants (Salachana and Zawadzińska, 2013). PBZ caused to an increase of leaf thickness by increasing the thickness of cuticle, leaf epidermis, palisade and spongy layer in *Catharanthus roseus* (Jaleel et al., 2007).

Leaf weight ratio (LWR): The use of flurprimidol and paclobutrazol preplant bulb soaks did not affect the LWR of narcissus (Table 4). There was no difference among the applications for leaf weight ratio. Probably this was because of not only increasing the leaf dry weight but also increasing the total dry weight of *Narcissus tazetta* (Table 4).

Table 4. Effects of PBZ and FP on the LWR and SWR of *Narcissus tazetta* L. Mean ± SE
Çizelge 4. PBZ ve FP'nin Narcissus tazetta'da OYA ve OGA üzerine etkileri Ortalama ± SH

Treatments	LWR (g/g)	SWR (g/g)
Control	0.09 ± 0.01	0.83 ± 0.090
Ethanol	0.09 ± 0.09	0.81 ± 0.020
100 mg L^{-1} PBZ	0.09 ± 0.01	0.83 ± 0.014
200 mg L^{-1} PBZ	0.10 ± 0.02	0.86 ± 0.020
10 mg L^{-1} FP	0.09 ± 0.01	0.84 ± 0.017
20 mg L^{-1} FP	0.10 ± 0.05	0.87 ± 0.012
Sig.	0.116*	0.201*

SE: Standard Error, LWR: Leaf weight Ratio, SWR: Stem weight ratio, *Not significant

Stem weight ratio (SWR): Statistically significant difference was not found (P>0.05) in SWR (Table 4). In the narcissus, bulbs were considered as the stem therefore the stem weight ratio is the ratio of stem (bulb) dry weight to the total plant dry weight. Gibberellin inhibitor treatments of uniconazole and daminozide reduced dry weight of stem in *Chrysanthemum* (Schuch, 1994). Stem and leaves dry weights of Kalanchoe reduced by uniconazole and paclobutrazol (Lee et al., 2003), but stem weight ratio has not been studied.

CONCLUSIONS

In conclusion, gibberellin inhibitors at lower concentrations used in this study significantly controlled the plant height in *Narcissus tazetta* both during the greenhouse and postproduction period with no adverse effect on flower life. Therefore, the pre-plant bulb soak treatments of 10 mg L^{-1} FP or 100 mg L^{-1} PBZ were suggested in order to provide plant height control and to maintain post production quality of *Narcissus tazetta* grown in pots. As to effects of treatments on growth parameters, both gibberellin inhibitors decreased the specific leaf area and leaf area ratio by decreasing the plant height, therefore significantly increased leaf thickness and dry weight of leaves in unit area. In addition, these results on growth parameters revealed that quantitative analysis could be used other related studies in geophytes.

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Contribution of the Authors as Summary

The authors declare the contribution of the authors is equal.

Statement of Conflict of Interest

The authors have declared no conflict of interest.

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