THE EFFECTS OF SHADING TREATMENTS ON THE PLANT GROWTH RATE OF SOME VARIETIES OF ASTER FLOWERS (*DAHLIA* SPP.) IN THE ECOLOGIC CONDITIONS OF TOKAT (TURKEY)

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Abstract. Aster flowers belong to the Asteraceae family which has approximately 1.000 genera, and a number of species approaching 25.000. It is the largest family of the flowering plants and has spread to almost every region of the world, except for Antarctica. Considering the relatively low number of studies in the literature regarding the subject, this study was conducted to determine the shading requirements of the *Dahlia* spp. The experimental tests were conducted in the facilities of the "Agricultural Applications and Research Directorate" of Gaziosmanpasa University in the city of Tokat. Observations and measurements were made regarding the yield, flower diameter, plant height, plant stem diameter, pedicle length, pedicle width, number of buds, bud diameter, and lifetime-in-pot properties of the *Le Castel, Seattle, Babylon Purple*, and *Gloriosa* genera of the *Dahlia* spp. The results obtained indicate that the tested shading practices (35% and 55%) have resulted in increased performances compared to the control group in terms of yield and quality. Between the genera, *Le Castel* genus has given better results compared to others in terms of yield in both 35% and 55% shading. In pedicle length, *Babylon Purple* genus has given better results with 35% shading, while *Gloriosa* was the best in that regard with 55% shading. For the flower diameter property, the best results (249.05 mm) were obtained in the third measurement by *Babylon Purple* with 35% shading practice. As a result, the difference between plant diameters of the genera under the shading practices were found to be statistically significant, and that 35% shading practice was ideal for all the genera tested.
Keywords: *ornamental plant, bulbous plants, aster, growing, Klux*

Introduction

Bulbous and tuber plants have attractive flowers with interesting shapes and colors, and they bloom relatively early (Yazici and Gülgün, 2016). Especially towards the end of winter months, their flowers bloom as soon as the snow melts away, which makes them a tell-tale sign of the spring. They are also grown with relative ease. All these reasons have made them one of the most commonly used plants in gardens and parks all around the world (Mathew, 1987; Mathew and Swindells, 1994; Leeds, 2000). In Turkey, around 700 flower bulb species grow naturally (Karagüzel et al., 2007). As the significance of the diversity and richness of Turkey's flora was recognized by authorities of other countries, the flower bulbs were gathered from the wilds with the purpose of exhibiting them in botanical gardens. This practice transformed into commercial purposes over time, and the level of destruction of their natural habitats increased.

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Amongst bulbous plants, Aster flower of the Asteraceae family is especially preferred as an outdoor ornamental flower. Most of the plants in this family are annual or biennial flowers, and very few are in bush or tree forms. The flowers have the shape of stars, while the leaves are either simple or are compound leaves in the shape of badges (Kim et al., 1992; Villasenor and Martiez, 2018). Aster flowers have around 30 prominent species and around 20.000 breeds. The flower naturally grows in the Central America continent, especially in the high mountains of Mexico. The flowers bloom in summer and fall. The stems are of brier type, while the roots are tuberous. 27 species of it can be found in nature. Some of these species may reach up to 8-9 meters height, while others are scrubs (Brickell, 1992; Hessayon, 1993; Mc Claren, 2004; Alp, 2008). Starting in July, they continue to bloom flowers, until the arrival of the first cold-weather waves. In temperate regions, they bloom much earlier, and the variation of their plant height and flower shapes and sizes increase. Their flowers can be of many shapes: simple, lotus, anemone, powder puff, orb, semi-cactus, cactus, decorative, orchid, or peony. In addition to the shades of blue, the flowers also contain all of the warmer colors. There are very few literature studies in Turkey regarding the Aster flower. Since it is a plant that can be produced relatively easy due to its large bulb resembling a potato, it is a good candidate for commercial use in the ornamental plant sector.

This study aims to evaluate the adaptation capabilities of the ornamental plant known as the Aster flower (*Dahlia* spp) and to determine the shading practices most suitable for the plant under the ecological conditions Kazova plains of the city of Tokat. A secondary objective is to determine the suitability of the Aster flower (*Dahlia* spp.) for plant design. Hopefully, this study will be able to determine optimal shading practices for the plant and act as a precursor for the growers that want to grow ornamental plants as the city of Tokat. We believe a new plant can thus be introduced to the ornamental plant design patterns places similar to Tokat ecological conditions, and *Dahlia* spp. can become an important part of decorative flowers. In addition, it could also contribute to application appropriate shading, varieties and to develop different studies in similar climatic conditions areas.

Literature review

American Dahlia Society officially lists 15 colors for the Dahlia: bicolor, bronze, dark blend, dark pink, dark red, flame blend, lavender, light blend, orange, pink, purple, red, variegated, white, and yellow. It can be used as a cut flower, or as an ornamental plant for outdoor environments. Those grown from the tubers have large flowers, while those grown from seeds have smaller ones (Evans, 1998; Mc Claren, 2004; Önay, 2007; Romer, 2008).

Hertogh and Nard (1992) and Mc Claren (2004) state that Aster flowers have flat receptacles, and that while the flowers on the edge are tongue-like in form while the ones on inner areas are more tubular. The flowers have a wide variation of colors. The leaves are bilateral, are of single or three bodies, and have serrated edges. Aster flowers are quite varying both in flower form and in color. It is also possible that a layered type aster flower can transform into a semi-layered form, along with a change in its color. The ones with two colors may lose one color over time. It is also reported by these researchers that the same plant may grow flowers of a different color over different branches.

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In another shading practice study, the effects of shading on the rooting properties of the "Choot Hashani", "Orpheo" and "Lavanta Perfection" genera of the Dahlia spp. were evaluated. Natural light density has caused about 50% rooting reduction in the "Orpheo" slips, while it had no effect on the rooting rate of the "Lavanta Perfection" slips (Brian and Halevy, 1973). Shading during daylight hours has caused longer internodes for the "Orhpeo" genus only, while it had no effect on the rooting rate. On the other hand, the same shading has caused increased rooting for the "Choot Hashani" genus. Shading the bases of the slips has caused rooting percentage and roots per slip to increase significantly. The variance in response to shading is still being discussed, and the shading practices for these genera were determined to have influence only when applied to the rooting area. It is being surmised that shading incentivizes the weedy character of the rooting area, resulting in improved rooting (Brian and Halevy, 1973).

According to another study; excessive sunlight, high temperature, low humidity and sunlight caused problems in *Dahlia* spp., but the amount and intensity of sunlight should be adjusted to increase the flower stalk length and flower color quality with shading applications (Lumpkin and Lumpkin, 2005). According to another study on dahlia; different levels and combination of bio fertilizers and organic manures was applied to assess the vegetative, floral and yield characteristics of dahlia. The experiment was laid out in randomised block design with ten treatments and three replications. The maximum plant height (65.07 cm), number of primary branches (9.67), number of leaves (33.67), plant spread (43.73 cm), number of flowers (8.13), duration of flowering (10.53), flower yield ha-1 (33.65), weight of tuber (56.67 g), number of tubers (4.87) and tuber yield (13.80 t ha^{-1}) were produced in the treatment. (Pandey et al., 2017). The experiment of Verma and Kulkarni (2017) was laid out in simple randomized block design with three replication and twenty treatments on dahlia. Significant differences for all growth and yield parameters were found among different genotypes of dahlia. Maximum plant height (122.38 cm), number of branches (13.15), stem girth (1.48 cm) plant spread (59.12 cm) and intermodal length (18.04 cm) were recorded in genotype Hiranmoyee whereas, maximum leaf area (1909.78 cm^2) was recorded in genotype Barakanchari. Maximum number of flowers per plant (25.30) was found in genotype Hiranmoyee whereas, maximum flower yield per plant (g) was found in Song of India (718.72 g).

Materials and methods

The study was conducted in the fields of Center of Agricultural Research and Applications in the city of Tokat (Turkey), under the ecological conditions of the Kazova plains in the year 2018. After harvest, the plants were left to pot life in the laboratories of Gaziosmanpaşa University Faculty of Agriculture Department of Garden Plants.

Materials

The plants which had the most commonly sought-after colors were used in the study: white and pink speckled yellow-red and yellowish-orange. The plant has great potential for use in ornamental plant sector, especially as an outdoor environment ornament. The plant materials for the study were obtained from Konya Asya Lale Production Company, which were mostly created by hybridization of *D. pinnata* and

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D. coccinea species. The types obtained and used in the study are given in *Figure 1a–d.* Also photographs from the experimental field are *Figure 2a* and *b*.

a **b** **c** **d**

Figure 1. a. *Seattle,* ***b.*** *Babylon Purple,* ***c.*** *Le Castel,* ***d.*** *Gloriosa*

a **b**

Figure 2. *Photographs from the experimental field*

Method

Dahlia spp. tubers were planted to the garden belonging to the GUTAM (Gaziosmanpaşa University Agricultural Application and Research Center) in three different shading applications (open, 35%, and 55% shading). The light intensities in the applications were measured by light meter (400,000 Lux / 40,000 FC) at 12:30 pm. Light intensities at three different points were measured and averaged. These averages were 97.6 Klux in open area, 66.8 Klux in 35% shading and 48.1 Klux in 55% shading. The growth environment was loamy-sand garden soil. Considering that the flowers are relatively large, the plants were seeded in a 50 × 50 cm grid, to a depth of 15 cm. Each repeat had 8 tubers and there were a total of three repeats, separated into two rows. A total of 288 *Dahlia* spp. tubers were thusly used. The tests were repeated three times with "parcels divided by randomized blocks" method, and each repeat had 8 tubers. After the variance analysis, the averages were compared using Duncan test (Düzgüneş et al., 1987).

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Results

Phenological findings

Vegetation period

This period was defined as the time it takes for 50% of the tubers after seeding to grow into plants that reach the soil surface. The Aster flower tubers that were sown on May 26 vegetated on June 11, in 15 days.

Inflorescence period

This period was defined as the time it takes for 50% of the plants flowering after being sown. The non-shaded (control group) tubers that were sown on May 16 flowered 35 days later, in the 1st of July, while those under 35% shading flowered 40 days later in 6th of July and those under 55% shading flowered 44 days later, on July 10th.

Floral period

This period was defined as the time it takes for 50% of the plant flowers to wither and fall. The plants that were not shaded which bloomed in 6th of July kept their flowers for a period of 85 days, till the 29th of September, while those under 35% shading kept their flowers for 96 days and those under 55% shading kept them for 103 days.

Leaf coloration period (days)

The leaf coloration was observed on the flowers for a total of 141 days, from the day 50% of the plants reached their vegetation period (June 11) till October 30th.

Abscission period

This period was defined as the time it took for 50% of the leaves to fall and was determined as 158 days from the plants' vegetation (June 11) till November 16th.

Morphological observations

Yield (pcs)

Inspected independent from the type, the general averages indicate that shaded plants yielded more flowers in the first harvest, compared to the control group. Those under 35% shading yielded an average of 20.58 flowers and achieved better flower yields compared to those in the control group and the 55% shaded group. The plants under 35% and 55% shading yielded significantly more yields in second and third harvests, compared to non-shaded plants. When the interaction between the flower genera and the shading level are inspected, it can be seen that the Seattle and Babylon Purple flowers under 35% shading yielded more flowers (with 15.66 and 17.66 units respectively), compared to the control and 55% shaded plants *(Fig. 3a).*

Flower diameter (mm)

Inspected independent of plant type, the plants under shading achieved higher flower diameters compared to non-shaded plants. Inspection of interaction between the shading application and plant genera reveals that *Le Castel, Seattle*, and *Babylon Purple* plants in the control group bloomed flowers with a significantly lower diameter in the first

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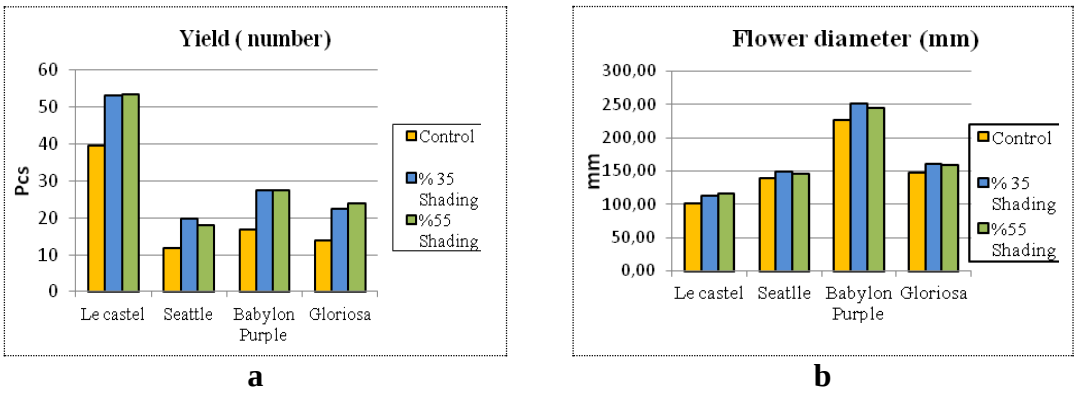
control (25th of July) compared to shaded groups, with 121.25, 157.69, and 249.38 mm, respectively. In the third measurement (25th of September), the plants under shading application (*Le Castel*, *Seattle*, *Babylon Purple*, and *Gloriosa*) were found to have larger-diameter flowers compared to the control group. When the plant genera are compared to each other, Le Castel is found to be the one with the lowest flower diameter (121.25 mm), while Babylon Purple had the largest flower diameter (249.38 mm). The difference between *Seattle* and *Gloriosa* types were found to be insignificant (157.69 and 165.35 mm respectively). Le Castel plants under 35% and 55% shading had the smallest diameter flowers, while *Babylon Purple's* under shading had the largest (*Fig. 3b).*



a **b**

Figure 3. a. *The yied in Dahlia spp. some varieties.* ***b.*** *The flower diameter in Dahlia spp. some varieties*

Pedicle length (cm)

Inspected independent of plant type, the plants under 35% and 55% shading were found to have significantly longer pedicles in all three harvests compared to the control group plants. When the interaction between the flower genera and shading levels are inspected in this regard, it can be seen that *Le Castel* and *Seattle* type flowers of the control group had significantly shorter pedicles (23.5 and 20.92 cm, respectively) compared to shaded plants. The *Babylon Purple* plants under 35% shading, and *Gloriosa* plants under 55% shading achieved significantly longer pedicle lengths compared to the plants in the control group, with 34.24 and 32.35 cm, respectively. Regarding the shading application's effect on the plant genera, 35% and 55% shaded *Babylon Purple* flowers, and 55% shaded *Gloriosa* flowers were found to have significantly longer pedicles overall, with 34.24, 30.97, and 32.35 cm, respectively (*Table 1*).

Pedicle width (mm)

Inspected independent of plant type, the plants under 55% shading had significantly wider pedicles (6.56 mm) compared to the plants in 35% shading and control group. In the second harvest measurement, the plants under 55% shading had wider pedicles compared to the control group as well (5.15 and 4.86 mm, respectively). No significant difference was found between the pedicle widths of the flowers in the third measurement. Inspection of shading application with the plant genera reveals that Le Castels under 35% shading had thinner pedicles (3.77 mm) compared to those under no

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shading, or under 55% shading. Babylon Purple plants under 55% shading, on the other hand, were found to have wider pedicles (8.60 mm) compared to control and 35% shaded groups in the first measurement in 25th of July. The Babylon Purple plants also had wider pedicles (6.22 mm) in the second measurement (25th of August) compared to other groups as well. In the third measurement, Le Castel plants of the third measurement under 35% and 55% shading were found to have significantly thinner pedicles compared to other types as well (*Table 1*).

Table 1. *Statistical data of the pedicle length and pedicle width of Dahlia spp. some varieties*

Pedicle length									
Varieties	**Harvest 1**			**Harvest 2**			**Harvest 3**		
	Control	**35% shading**	**55% shading**	**Control**	**35% shading**	**55% shading**	**Control**	**35% shading**	**55% shading**
Le Castel	23.50bB	28.06bA	28.14bA	20.60bB	24.96cA	25.23cA	19.37bB	26.61aA	27.32aA
Seattle	20.92cB	27.98bA	28.62bA	14.65cB	27.14bA	26.89bcA	12.94cB	26.25aA	27.86aA
Babylon Purple	29.45aB	34.24aA	30.97aAB	25.60aB	29.17aA	28.31bAB	24.31aB	26.75aA	26.35aA
Gloriosa	27.74aB	30.78bAB	32.35aA	25.82aB	29.16aA	30.47aA	23.14aB	27.46aA	27.37aA
General average	25.40B	30.27A	29.71A	21.67B	27.61A	27.43A	19.54B	26.76A	27.27A
Pedicle width									
Varieties	**Harvest 1**			**Harvest 2**			**Harvest 3**		
	Control	**35% shading**	**55% shading**	**Control**	**35% shading**	**55% shading**	**Control**	**35% shading**	**55% shading**
Le Castel	4.22bA	3.77bB	4.29cA	3.47bA	3.89bA	3.62cA	3.11bA	3.31bA	3.23bA
Seattle	6.90aA	6.65aA	6.55bA	5.41aA	5.55aA	5.28bA	5.12aA	5.34aA	4.96aA
Babylon Purple	6.62aB	6.68aB	8.60aA	5.22aB	5.56aAB	6.22aA	4.85aA	5.13aA	5.91aA
Gloriosa	6.84aA	6.42aA	6.91bA	5.34aA	5.34aA	5.56abA	4.95aA	5.04aA	5.24aA
General average	6.14B	5.88B	6.56A	4.86B	5.09AB	5.15A	4.48A	4.70A	4.81A

Bud (gemma) count (pcs)

When the average bud count is inspected independent of the plant type, the first harvest's plants under 35% shading had more buds (4.45) compared to the control and 55% shading groups. In the second and third harvests' measurements, the plants in the control group developed significantly fewer buds compared to 35% and 55% shaded plants. The inspection of interaction between shading practices and the plant types reveals that *Seattle* and *Babylon Purple* plants developed more buds (2.54 and 3.20 respectively) compared to the control and 55% shading group plants in the first harvest's measurements made in 25th of July. Le Castel plants in the first harvest measurement developed more buds (7.62) compared to others (*Fig. 4a).*

Bud diameter (mm)

Type-independent inspection of the averages reveal that 35% and 55% shaded plants have developed larger flower buds compared to the control group. The 35% shaded

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plants of the second harvest have developed significantly larger buds compared to the 55% shaded plants. The inspection of interaction between plant types and shading practices reveals that the control group *Babylon Purple* plants of the first harvest of 25th of July have developed smaller flower buds (28.75 mm) compared to the 35% and 55% shaded plants. 35% shaded *Le Castel* and *Gloriosa* plants of the second harvest of 25th of August, on the other hand, developed larger buds (19.45 mm and 27.44 mm respectively) compared to others. The plants under 35% and 55% shading of the third harvest (*Le Castel, Seattle, Babylon Purple* and *Gloriosa*) have developed significantly larger buds compared to the control group plants. For plant types, the largest buds were developed by the 35% shaded *Babylon Purple* plants of the first harvest (31.70 mm), while *Le Castels* developed the smallest buds (21.79 mm) (*Fig. 4b).*

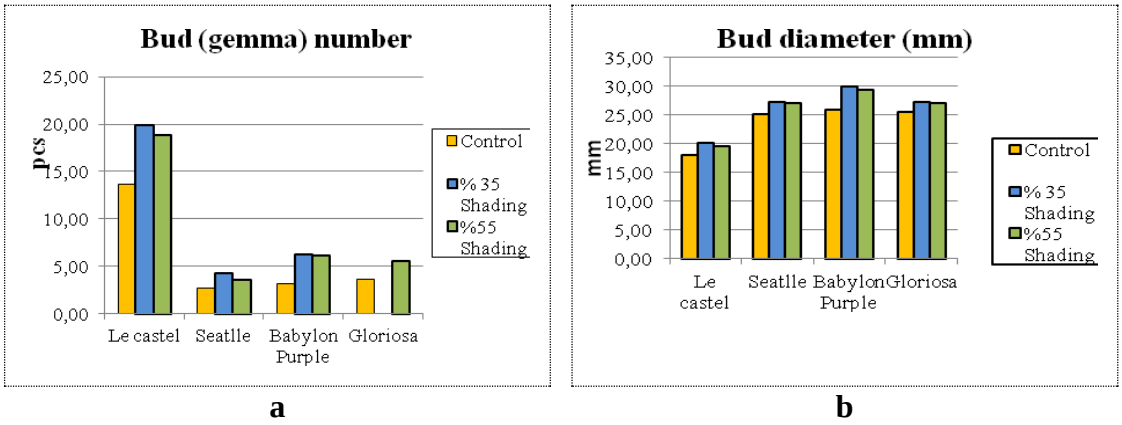

Figure 4. a. *The bud number in Dahlia spp. some varieties.* ***b.*** *The bud diameter in Dahlia spp. some varieties*

Plant height (cm)

When the averages are inspected independent of plant type, 35% shaded plants were found to have developed higher (77.14 cm) compared to the control and 55% shaded groups in the first harvest. In the second harvest, shaded plants reached a higher size compared to the control group. In the third harvest, the longest plants were developed by the 35% shaded plants (133.54 cm), while the smallest ones were developed by the control group (110 cm). The analysis of type-shading interaction reveals that the *Le Castel* plants of the control group in the second harvest of 25th of August developed shorter plants (96.37 cm) compared to the ones in the 55% shaded group (111.66 cm.) *Seattle* plants under 55% shading developed to be longer (92.27 cm) compared to the control group plants (64.56 cm). *Babylon Purple* and *Gloriosa* plants of the control group were shorter (120.93 cm and 113.53 cm, respectively) compared to the shaded ones. *Le Castel* plants developed longer (111.66 cm) compared to *Seattle* plants (92.27 cm). The *Gloriosa* plants of the third harvest under 35% shading grew to be longer (151.55 cm) compared to the *Le Castels (Fig. 5).*

Stem diameter (mm)

Type-independent evaluations reveal no significant variation in terms of stem diameter. When the effects of shading application on various types of plants are inspected, it can be seen that *Gloriosa* plants under 35% shading in the first harvest of

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25th of July have developed larger stems (15.60 mm) compared to the *Le Castel* (11.29 mm) plants. No significant differences were observed between 55% shaded *Seattle* (18.23 mm) and *Babylon Purple* (18.39 mm) plants. The second harvest's (25th of August) Le Castel plants developed thinner stems (12.11 mm) compared to the Seattle plants (18.01 mm). *Gloriosa's* under 35% shading developed larger stems (17.94 mm) compared to the *Le Castel's* (11.55 mm). No significant difference was observed between 55% shaded *Babylon Purple* and *Gloriosa* plant stem diameters (22.23 mm and 18.72 mm respectively). The Seattle plants of the third harvest (25th of September) developed larger stems (20.26 mm) compared to the Le Castel plants (13.83 mm). Le Castel plants under 35% shading developed thinner stems (13.31 mm) compared to other plants. No significant difference was observed between 55% shaded Babylon Purple and Gloriosa plants (23.94 mm and 22.79 mm, respectively) (*Fig. 6a*).

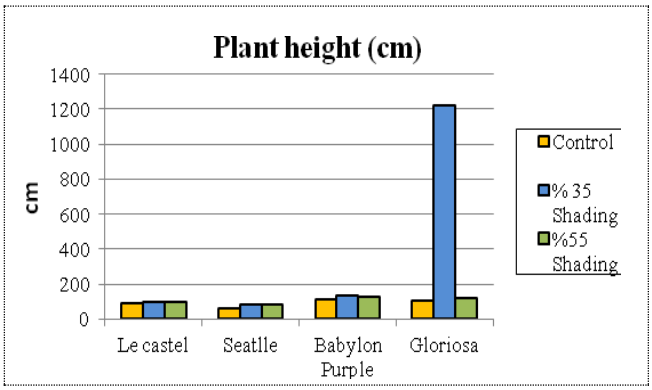
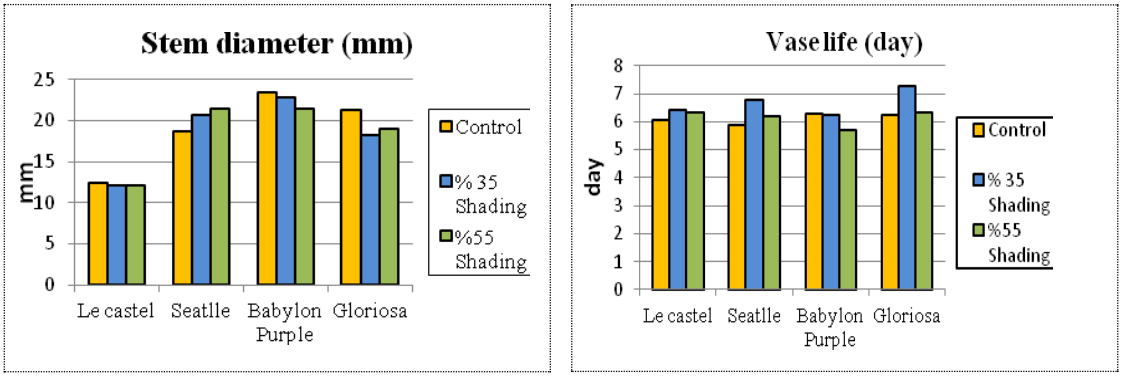


Figure 5. *The plant height number in Dahlia spp. some varieties*



a **b**

Figure 6. a. *The stem number in Dahlia spp. some varieties.* ***b.*** *The vase life in Dahlia spp. some varieties*

Vase life (day)

The vase life of flowers is commercially important because of storage. After the harvest, fading time of flower was examined in pure water. Type-independent inspection reveals that 35% shaded plants had significantly more vase lifetimes compared to control and 55% shaded groups in the first and second harvests, and in total average. Type and shading based inspection reveal that 35% shaded *Le Castel* and

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Gloriosa flowers of the first harvest of 27th of July have survived longer in the vases (6.58 and 7.41 days respectively) compared to control and 55% shading groups. Amongst the flowers of the second harvest of 27th of August, the Seattle flowers of 35% shading survived longer in a vase (6.91 days) compared to other groups. On average, Seattle and Gloriosa flowers under 35% shading were found to survive longer in a vase (6.79 and 7.29 days respectively) compared to control and 55% shading (*Fig. 6b*).

Discussion

The evaluations on the collected data reveal that shading practices (35% and 55%) have resulted in positive developments regarding total yield and some quality criteria compared to the control group. In terms of yield, the inspection of shading practices reveals that the plants of second and third harvests have developed more flowers compared to the control group when 35% and 55% shading was applied. Evaluation of the plant types in terms of yield (*Le Castel*, *Seattle*, *Babylon Purple*, *Gloriosa*) reveal that Le Castel plants were significantly yielding compared to other plants in all three harvests. Amongst the third harvest plants, Le Castels under 55% shading yielded the highest amount of flowers (85.33). According to the study of Akçal (2016), plants subjected to 16 h of photo-period under 40% shading displayed a more uniform development and resulted in more compact flowers suitable for decorations. Similarly, the results of our study indicate that 14-15 h of photo-period under 35% shading result in more uniformly developed plants which were more suitable for use as outdoors ornamentals.

The results also indicate that 35% and 55% shading practices also increase the plant height and flower diameter. This is similar to the findings of Yanming Dent et al. (2012), which indicates that 20-50% shading for Jasmine (*Jasminum sambac Aiton*) plants have resulted in increased vegetative growth and yield. Similarly, both the 35% and 55% shading practices in our study resulted in better vase lifetime, stem diameter, plant height and yield. The study of Malta (2016) also report similar results, in which 35% and 55% shading practices for tulips (*Tulipa gesneriana L.*) have resulted in better properties in terms of flower lifetime, pedicle length, flower diameter and corm size.

Pedicle length is an especially important property for the cut flower sector. In terms of pedicle length, the plants under 35% and 55% shading were found to have developed longer pedicles compared to the control group plants in general. Even though *Babylon Purple* and *Gloriosa* types have similar properties in this regard, the *Babylon Purple* type flowers have developed the longest pedicles (32.24 cm) in the first harvest under 35% shading.

When all these criteria are evaluated together, it can be surmised that shading practices of 35% and 55% result in increased yields for the Aster flower overall. In some climate-related events like rainfalls, the 55% shaded plants were found to have developed form irregularities towards their centers. Considering all of these, we report that the ideal point lies in 35% shading for the Aster flowers in places such as Tokat Kazova conditions.

Conclusion

Although it is known that the Dahlia's need shadow what kind of dahlia to how much shadow (Klux) are important. As shown in this study, the responses of the varieties to

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shadow applications were found to be significant. After this study, the amount of shade should be taken into consideration in landscaping applications for Dahlia's. In addition, the use of varieties (*Bayblon purple Seattle, Glorissa, Le castel*) should be evaluated according to their development in the shade in the light of the obtained data.

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