Effect of Photoperiod on the Flowering of Some Cultivars of Hydrangea (Hydrangea macrophylla)

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Abstract The experiment was conducted in Hama governorate (Bammraa village) in Syria during the spring and summer seasons 2013-2014 to study the effect of photoperiod on some production indicators (Date of flowering, Number of flower clusters, Number of flowers, Diameter of flower cluster and length stem). Floral induction of three Hydrangea macrophylla. Ser cultivars (“Mme. Emile Mouillère”, “Nikko Blue”, “Pia” was evaluated to determine the flowering. Plants were tested under either natural day length (ND) or 24-hours-extended day (ED) or 8-hours short day (SD). Floral induction of H. macrophylla occurred under all treatments but was more rapid under ED. Number of flower clusters, flower numbers and diameter of flower cluster were significantly different for cultivars and photoperiods. Floral initiation and development were observed among photoperiods. Results indicated that ED was the best in all production indicators (Number of flower clusters, Number of flowers, Diameter of flower cluster and length stem) in the cultivars with significant differences. In addition, the results showed that the cultivar (Nikko blue) was more responsive in all production indicators but, the amount of anthocyanin was more in deep pink sepals than blue sepals.

Keywords Hydrangea; Cultivars; Photoperiod; Number of flower clusters; Number of flowers; Diameter of flower cluster; Length stem; Anthocyanin

Introduction The Hydrangea genus contains about 70-75 species of various flowering plants (Jones and Reed, 2006). This scientific name comes from two Greek words “Hydro” and “aggeino” which means “water vessel” (Lassiter, 2000).

Most of these species are shrubs, some are small trees, while others are of the climbing variety (Bailey, 1998). It has a beautiful, perennial bush with huge flower heads. These deciduous bushes profusely produce huge, round flower heads which have two kinds of florets: Sterile, or ray florets, are male and form the large, colorful sepals on the outside of the flower head. The fertile florets bear the male and female parts and are usually found in the center of the cluster, these fertile flowers surrounded by a large mass of sterile "flowers" called sepals (Movahed et al., 1969). Flowering of these plants are produced by the plant from early spring to late autumn. Hydrangea are native to North and South America, Himalayas, central and eastern Asia (Dirr, 2004).

Hydrangea macrophylla is a species of Hydrangea and it is the only species that is spread in Syria in the coastal and mountain areas. Common names include big leaf Hydrangea, French Hydrangea, Lacecap Hydrangea, Mophead Hydrangea, Penny Mac and Hortensia (Adkins and Dirr, 2003). It is widely cultivated in many parts of the world in many climates (Jessica, 2008). In most species the sepals are white in color, but in others the sepals can be changed to blue, red, pink, or purple (Smith et al., 2008). Hydrangeas are very popular plants for ornamental purposes, people seem to love them for their large flower heads (Albatal, 2003). The color of hydrangeas will vary considerably due to the pH of the soil they are growing in (Tilt, 2008). Kikelly (2006) reported that the blue hues are best in acid soil and the degree of blueness is controlled by the amount of available aluminum and the capacity of a particular variety to draw it up. The reds and pinks enjoy an alkaline or neutral soil where aluminum is not actively absorbed. The whites stay white but usually enjoy the same conditions as the...
reds and pinks. Potted hydrangeas remain popular despite challenging production requirements. Physiological requirements for floral induction make year-round production cost prohibitive. In temperature climate, winter temperatures below -23°C and early fall or spring frosts often kill flower formed during the previous season (Adkins et al., 2002; Huxley et al., 1992). Pot plants producers rely on naturally occurring photoperiod in the summer and fall for vegetative growth and floral induction (Struckmeyer, 1950). In order to investigate the potential for production, research on the influence of photoperiod, temperature, light intensity, and chemical growth regulators on floral induction and development has been conducted (Bailey and Weiler, 1984; Bailey et al., 1986; Littlere and Strømme, 1975; Vidalie, 1986). Littlere and Strømme (1975) reported that a photoperiod between 8 to 12 hours are inductive whereas photoperiods more than 16 hours are noninductive. Our aim in this research is to study the effect of photoperiod on the production of Hydrangea plants in our country.

The aim of this research: As Hydrangea plant is considered a long-day plant, but the effect of photoperiod in the productivity of this plant is unknown, so it was necessary to study the effect of the length of photoperiod on the quality and color of the flowers in Hydrangea plants.

Materials and Methods

Used Plants: In this work, three cultivars were used of the species Hydrangea macrophylla. The first cultivar is Emile Mouillère (a cultivar with white color flower), the second cultivar is Nikko Blue (a cultivar with blue color flower) and the third cultivar is Pia (a cultivar with deep pink color flower).

These plants were three years old and planted in pots (one plant in every pot), the media was peat moss and perlite (2:1).

Study Area: The study was in Bamra village in Hama. Bamra is considered as a mountaineer village which its altitude is more than 900 m above the sea, this height cause a very cold winter and a cool summer. The climate is wet and rainy for about eight months in a year, the rainfall average is about 1500-2000 mm in the year, the average of maximum temperature is about 22°C, the average of minimum temperature is about 10°C, the average of humidity is about 74.68%. The chemical analysis was done in the laboratories of Agriculture college in Damascus university, Syria.

The experiment was laid out according to Randomized Complete Block Design (RCBD) with three replications (three blocks), the data were analyzed using SPSS program to find the differences between the means of all the studied treatments and least significant differences (LSD) at 0.05 level of significances.

Treatments: There were three treatments:

The first, leaving plants under natural day length (ND). The second, plants were maintained under a 24-h photoperiod by using white light (fluorescent plus incandescent of about 18,000 lux) after ending the natural light day (ED). The third, plants were maintained under a natural day for 10 hours and then to 14-hours darkness by sheathing them with black cloth (SD).

The plants were three years old and planted in pots (one plant in every pot), the media was peat moss and perlite (2:1). It was used three replications in every treatment and in every replication there were six plants so in every treatment there were eighteen pots of the plants (for every cultivar) one plant in every pot. These treatments were done in the middle of February month in 2013 at the time that buds didn’t appear yet. After the leaves were appeared, all plants were put under a controlled environment continuously with treatment as following:

Media: The media that all plants were planted in it was peat moss and perlite (2:1).

Temperature: (27.2°C ± 2), a thermometer was used to measure the temperature.

Humidity: It was about (53% ± 5). A hygrometer was used to measure the humidity.

Radiance: It was about 25000 lux, it was measured by luximeter.

Investigated traits:
The date of initiation of first flowering cluster and the date of ending of flowering were recorded.
Other studied parameters (Number of flower clusters-Number of flowers in each cluster-Diameter of the cluster) have been recorded at complete flowering stage (August).

**Anthocyanin content:** The anthocyanin content was measured as following (Pharr et al., 2006):

Sepals from hydrangea cultivars were harvested at full bloom, weigh about 1g of sepals and they were torn at least twice.

Add 7mL of 1% HCl in methanol (it prepared by mixing 99 mL of methanol and 1mL of HCl).

The sepal-extract slurry was vigorously mixed on a magnetic stirrer for about thirty minutes, after which the sepals had lost essentially all their color and the extract turned red-pink (independent of the initial color of the sepals) then the extract was decanted.

Buffers at pH1 (0.025 M KCl) and pH4.5 (0.400 M NaC2H3O2) were prepared and adjusted to be within ± 0.01 of the desired value (NH4OH was added to increase the basicity of the buffer, or HCl to increase the acidity).

Exactly 2 mL of each buffer were pipette into separate small beakers, followed by adding 4 mL of anthocyanin extract to each beaker and the resulting extract-buffer solutions were equilibrated 15 minutes, then filtered to remove any particulates.

Spectra for both solutions were obtained from 700 to 533 nm on a scanning spectrophotometer.

Calculate the absorption A as in the following equation:

\[
A = (A_{533} - A_{700})_{\text{pH1}} - (A_{533} - A_{700})_{\text{pH4.5}}
\]

Calculate the concentration of delphinidin-3-glucoside in mg anthocyanin per g fresh sepals as following equation:

\[
(\text{delphinidin-3-glucoside}), \text{mg/g sepal} = \frac{(A \times M \times DF \times 10000 \times V)}{\epsilon \times m}
\]

A: Absorption
M: Molar mass of 465.2 g/mole
\(\epsilon\):molar extinction coefficient of 29000
DF: dilution factor (the total volume of extract-buffer solution divided by the volume of extract).
V: The volume of acidic methanol solution in ml used in the extraction.
m: the mass of sepals(mg).

**Results and Discussion**

**Effect of photoperiod on the date of flowering:**

It was noticed in the Table 1 that when the photoperiod decreased, the flowering initiation was delayed in all studied cultivars (Emile Mouillère, Nikko Blue and Pia) (Figure 1) and also caused an earliness in stopping of flowering. Emile Mouillère and Pia began to flower after five weeks from the date of beginning treatment in the ED and they flowered after six weeks in the ND, But Emile Mouillère flowered after nine weeks in the SD and the period of flowering in the extend day was thirteen weeks, while Pia flowered after ten weeks in SD and the period of flowering was sixteen weeks in the ED. Nikko Blue flowered after six weeks in ED, but it delayed in flowering to ten weeks in SD and eight weeks in ND, the period of flowering in this cultivar was fifteen weeks in ED. Also cultivar Pia flowered early after five weeks in ED

**Effect of photoperiod on number of flower cluster, number of flowers, diameter of flower cluster and Length of flower cluster stem:**

Results in Table 2 indicated that the number offlower clusters, number of flowers, the diameter of flower cluster and the length of flower cluster stem increased by increasing photoperiod. This was true in the three studied cultivars, however the cultivar Nikko blue recorded the highest values of them in all indicated parameters (3.78, 90.56, 9.92, 24.27). The results showed that the second treatment was the best treatment in all studied cultivars
Table 1 Effect of photoperiod on the date of flowering in the studied cultivars of *Hydrangea* (by week)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cultivar</th>
<th>Flowering initiation</th>
<th>Flowering end</th>
<th>Flowering period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Emile Mouillère</td>
<td></td>
<td></td>
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<tr>
<td>ND</td>
<td></td>
<td>6</td>
<td>18</td>
<td>12</td>
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<td></td>
<td>Nikko Blue</td>
<td>8</td>
<td>21</td>
<td>13</td>
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<tr>
<td></td>
<td>Pia</td>
<td>6</td>
<td>20</td>
<td>14</td>
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<tr>
<td>ED</td>
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<td>5</td>
<td>18</td>
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<td>6</td>
<td>21</td>
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<td>5</td>
<td>20</td>
<td>16</td>
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<td>SD</td>
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<td>9</td>
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<td>10</td>
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<td>10</td>
<td>18</td>
<td>8</td>
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<tr>
<td>Mean</td>
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<td>6.67</td>
<td>18</td>
<td>11.33</td>
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<td>12</td>
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<td></td>
<td>19.33</td>
<td>12.67</td>
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<tr>
<td>LSD 0.05</td>
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<td>5.17</td>
<td>0.10</td>
<td>5.17</td>
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<td></td>
<td>4.97</td>
<td>4.30</td>
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<td>8.96</td>
<td>6.57</td>
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<td></td>
<td></td>
<td></td>
<td>2.87</td>
<td>10.34</td>
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</table>

with significant effects in the above mentioned parameters. It was noticed that when the plants covered after ten hours light, the flower clusters, number of flowers, the diameter of flower cluster and the length of flower cluster stem were decreased in the three cultivars. The results also showed that the cultivar Nikko Blue have flower clusters, number of flowers, the diameter of flower cluster and the flower cluster stem length more than other cultivars in all treatments, and recorded the highest values of the previous parameters under ED (4.17, 102.44, 12.61, 28.17).

![Emile Mouillère](image1.jpg) ![Pia](image2.jpg) ![Nikko Blue](image3.jpg)

Figure 1 The three studied cultivars of *Hydrangea macrophylla*

Even though many species are responsive to extended photoperiod for flowering. However, they do have their optimal range. They are also dependent on quality and intensity of light as well. Extending photoperiod may promote flowering and increase number of flowers. However, other important parameters such as quality, size and weight are those desired parameters in commercial production. Various species showed reduced weight and size
when the photoperiod exceeds their optimal range. Especially, extending photoperiod incurs more production cost. Therefore, the study design should also be practical in finding the most cost-effective treatment for recommending in commercial production.

Struckmeyer (1950) reported that reproductive meristem development occurs during the dormant period following induction, and shoot expansion and flowering occur in early spring and summer, respectively and this is rely on occurring photoperiods that can accelerate the growth of meristem and then foliage growth and making flowers. The development of meristem in Hydrangea macrophylla will be in four stages: 1-meristem vegetative (no flower primordia distinguishable). 2-meristem reproductive (one to many flower primordia clearly distinguishable). 3-visible flower bud (floral bud visible to the naked eye without removal of leaves or leaf primordia). 4-one to many florets open with pigmentation developing and all these stages need a good photoperiod. Shanks (1991) and Haworth-Booth (1984) assured that increasing the photoperiod will produce early flowers in summer and more advanced floral development and that’s the same result in this research. But Adkins (2003) reported in his research that flowering initiation in some cultivars like Nikko Blue and Emile Mouillère had been done quickly under short day (8 hours) more than long day (24 hours) and but the cultivars with pink flowers need to along photoperiod (24 hours) as he mentioned. Mattson and Erwin (2005) assured that cultivars in the same variety differ from each other to the photoperiod that need. Our research showed an increasing in number of clusters and diameter of cluster and that the same as Theo (2007) who mentioned in his research that clusters number in Hydrangea increased under along photoperiod and Morita et al (1978) who assured that the long photoperiod will increase the leaf area, shoot length and flowers.

Effect of photoperiod on the amount of Anthocyanin in sepals:
There wasn’t any effect to the long photoperiod on the amount of anthocyanin in sepals in the two studied cultivars (Nikko Blue and Pia). ND (natural day) have more anthocyanin than ED and SD. Covering plants after ten hours caused a decreasing in anthocyanin in the two cultivars. Results showed also that deep pink sepals in cultivar Pia have more anthocyanin than blue sepals (Nikko Blue), as it was noticed in the Figure 2.
In conclusion, it was clear that the productivity of Hydrangea was increased by increasing the photoperiod but the increasing of photoperiod hadn't any effect on the formation of anthocyanin. There are many factors like photoperiod such as: temperature, humidity, radiance, fertilizing etc could effect on the quantity and quality of hydrangea flowers, and there are many questions need an answer about the relationship between them to get more colorful flowers. So, many researches must be continued about Hydrangea and about the environmental and agricultural factors that probably effect on it.

**References**


Asen S., Stewart N.R., and Norris K.H., 1977, Anthocyanin and pH involved in the color of "Heavenly blue" morning glory, Phytochemistry, 16: 1118-1119


Bailey D.A., 1998, Commercial Hydrangea Forcing, Department of Horticultural Science, University of Georgia, Published by North Carolina Cooperative Extension Service


Jessica A., 2008, Bay Landscaping News, Perennials, Plant Care, Why Are My Hydrangeas Not Flowering? Published on September 15th

Jones K.D., and Reed S.M., 2006, Production and verification of Hydrangea arborescens “Dardom” X H.involucrata Hybrids, publication of the American society for horticultural science, 41(3): 564-566


Lassiter M., 2000, I recently received a Hydrangea with beautiful pink blooms, Can this be planted out of doors. If so, How do I care for it? Galveston county
http://dx.doi.org/10.17660/ActaHortic.1975.51.30
Mattson N., and Erwin J., 2005, The impact of photoperiod and irradiance on flowering of several herbaceous ornamentals, Scientia Horticulturae, 104: 275-292
Phaar K.E., Mayhew K.M., and Schreiber H.D., 2006, Anthocyanin content in hydrangea sepals, Department of chemistry, Virginia Military Institute, Lexington, VA 24450, HS@VMI.edu
http://dx.doi.org/10.1021/ja01875a510
http://dx.doi.org/10.17660/ActaHortic.1986.181.33