The Role of Benzyl Amino Purine and Kinetin in Enhancing the Growth and Flowering of three Gaillardia Varieties

Ramy Gaber El-Kinany, Atef M. K. Nassar, and Ahmed A.A. El-Settawy

INTRODUCTION

Gaillardia (Gaillardia pulchella), a member of the family Asteraceae, is native to Florida and Central and Western United States (Anonymous, 2007). Its common name is blanket flower and it may have come from the resemblance of the flowers to brightly patterned Native American. The generic name Gaillardia stands in honor of M. Gaillard, a French patron of botany (Baily, 1947). Gaillardia is a flowering herbaceous annual or short-lived perennial (Helen et al., 2007). The annual gaillardia is propagated by seeds. The perennial forms can be propagated by cutting, division or seeds. Gaillardia popularly cultivated for its attractive colour flowers and for varied uses like cut flowers, making garlands, floral decorations and required for raising in garden as borders and beds and other ceremonial and social occasions. Gaillardia produces flowers in a wide range of colors such as orange, yellow, scarlet, cream, bronze, red and brick-red and can be grown all around the year (Shreedhar, 1993). Gaillardia flowers are small and numerous; born in solitary, usually showy heads which is stated as capitulum with 4 to 6 cm in diameter. Individual flowers in a capitulum are called florets which range from one to ten according to cultivar or genotype. As a member of Asteraceae it has both ray and disc florets which are pistillate and hermaphrodite, respectively in nature. Flower has a long hairy stalk and single, semi- double and double types with single or multicolored heads (Cox and Klett, 1984).

Two pot experiments were carried out during two successive winter seasons of 2015/2016 and 2016/2017 in a private commercial nursery located at Damanhour City, El-Beheira Governorate, Egypt. The objective of this research was to evaluate the effect of two synthetic cytokinins: benzyl amino purine (BAP) at 50 and 100 ppm and 6-furfuryl-aminopurine (kinetin) at 25 and 50 ppm, each alone, on the growth performance, yield and quality of three varieties (pulchella, Mesa Yellow and Lorenziana) of gaillardia (Gaillardia pulchella). The experiment was designed as a split-plot design containing three replicates. The obtained results of the two seasons, generally, revealed that Gaillardia pulchella var. pulchella had the highest plant and flowering growth parameters, (viz. number of inflorescence per plant and flowering duration). While, Lorenziana variety showed the best diameter, longevity, fresh weight and dry weight of inflorescence per plant. Spraying gaillardia plants with BAP and kinetin significantly enhanced vegetative, root and flowering parameters compared to the control treatment. From that, BAP at 100 ppm or kinetin at 25 ppm recorded the highest mean values of the most recorded data and might be considered as optimal treatment for the production of high yield and quality of gaillardia plants under the environmental conditions of El-Beheira Governorate and other similar regions.

Keywords: Plant growth regulators, Cytokinin, BAP, kinetin, Gaillardia.

ABSTRACT

Two pot experiments were carried out during two successive winter seasons of 2015/2016 and 2016/2017 in a private commercial nursery located at Damanhour City, El-Beheira Governorate, Egypt. The objective of this research was to evaluate the effect of two synthetic cytokinins: benzyl amino purine (BAP) at 50 and 100 ppm and 6-furfuryl-aminopurine (kinetin) at 25 and 50 ppm, each alone, on the growth performance, yield and quality of three varieties (pulchella, Mesa Yellow and Lorenziana) of gaillardia (Gaillardia pulchella). The experiment was designed as a split-plot design containing three replicates. The obtained results of the two seasons, generally, revealed that Gaillardia pulchella var. pulchella had the highest plant and flowering growth parameters, (viz. number of inflorescence per plant and flowering duration). While, Lorenziana variety showed the best diameter, longevity, fresh weight and dry weight of inflorescence per plant. Spraying gaillardia plants with BAP and kinetin significantly enhanced vegetative, root and flowering parameters compared to the control treatment. From that, BAP at 100 ppm or kinetin at 25 ppm recorded the highest mean values of the most recorded data and might be considered as optimal treatment for the production of high yield and quality of gaillardia plants under the environmental conditions of El-Beheira Governorate and other similar regions.

Keywords: Plant growth regulators, Cytokinin, BAP, kinetin, Gaillardia.
MATERIALS AND METHODS

Greenhouse experimental design

Two pot experiments were carried out during the two successive winter growing seasons, 2015/2016 and 2016/2017. The experiments were accomplished in a private commercial nursery located at Damanhour city in Beheira Governorate, Egypt under greenhouse conditions. Gaillardia varieties used during the study were Pulchella, Mesa Yiellow (both varieties have flower head appear single with either a classic daisy form) and Lorenziana (The central disc filled with trumpet-shaped, 5-petaled flowers). These varieties were chosen because of there fame. Seeds of Gaillardia were obtained from Ontario Seeds Company Ltd. Waterloo, Ont., Canada. Seeds were sown on 15 October in both seasons in 25 cm black plastic pots filled with soil consist of sand, silt, and clay as appeared in Table (1). After seed germination, plants were thinned to one plant per pot.

Soil samples were collected then physically and chemically analyzed according to Black et al. (1965). The analyses were carried out at the Natural Resource and Engineering Soil Department, Agriculture Faculty, Damanhour University.

### Table 1: Physical and chemical analyses of soil samples of the experiment.

<table>
<thead>
<tr>
<th>Physical analysis</th>
<th>First season</th>
<th>Second season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay (%)</td>
<td>0.77</td>
<td>0.72</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>7.00</td>
<td>8.03</td>
</tr>
<tr>
<td>Sand (%)</td>
<td>92.23</td>
<td>91.25</td>
</tr>
<tr>
<td>Texture class</td>
<td>sand</td>
<td>sand</td>
</tr>
<tr>
<td>Chemical analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC (dS/m)</td>
<td>0.80</td>
<td>0.87</td>
</tr>
<tr>
<td>pH</td>
<td>7.90</td>
<td>7.80</td>
</tr>
<tr>
<td>Ca (meq/L)</td>
<td>20.10</td>
<td>20.52</td>
</tr>
<tr>
<td>Mg (meq/L)</td>
<td>6.23</td>
<td>6.98</td>
</tr>
<tr>
<td>SO₄ (meq/L)</td>
<td>8.21</td>
<td>7.98</td>
</tr>
<tr>
<td>K (meq/L)</td>
<td>5.23</td>
<td>5.35</td>
</tr>
</tbody>
</table>

Aqueous solutions of Benzyl amino purine (BAP) and kinetin (manufactured by the Sigma-Aldrich Corporation) were applied as foliar spray at the concentrations of 50, and 100 ppm for (BAP) and 25 and 50 ppm for Kinetin and Distilled water was used as a control. The pot surface was covered with polyethylene before application to avoid falling of spray drips on the growing medium. All cytokinin concentrations were applied using a hand sprayer and non-ionic surfactant tween 80 at 0.05% (v/v) was added to all treatments to reduce the surface tension and increase the contact angle of sprayed droplets. Each plant was sprayed individually, so that, all foliage was moistened until the point of run-off. The spraying volume was 25 ml per plant. The untreated control plants were sprayed with distilled water.

Spraying plants was applied two times; the first one was carried out at flower initiation phase (Saffari et al., 2004 and Khatun et al., 2016), almost after five months from seed sowing. The second application was done 7 days after the first one.

The reason behind spraying gaillardia plants with cytokinin components when the plants entered flower initiating phase is due to the fact that spraying plants with cytokinins at the beginning of the plant life and the plant still small, leads to elongation in the plant cells and increases number of lateral branches and due to the nature of blanket flower growth where the plant is considered a tall herbaceous annual (more than 1 m long), which is usually subjects to slanting if it was grow alone in pot (Noor El-Deen et al., 2014). Also, the yield of flowers and its quality will be low because of the apical dominance which limits the production of flowers and reduces its quality. So the aim of this study was increasing the quality of flowers by increasing flower size and flower longevity or vase life which are the most important characters for commercial value of flowers (Sarfiuddin et al., 2009).
All cultural practices were applied whenever they were necessary and as commonly recommended in the commercial production of gaillardia. Irrigation was done as needed.

The following data were recorded:

**Plant growth characters**

Three plants from each treatment in each replicate were randomly chosen and tagged for collect vegetative growth traits, notably; plant height (cm) which was recorded from the first week of treatments application (almost five months after sowing of the seeds), number of branches per plant, leaf area (cm²) according to Zidan (1962), shoot fresh and dry weights per plant (g) were determined without the inflorescences and also for roots by the end of the experiment for all plants. Dry weights were determined by drying the plant samples in the oven at 70 °C till obtaining a constant weight, then left to cool inside the oven and weighed in grams. In all cases, the weight measurements were performed using a digital scale with a precision of 0.001 digits. Also, root growth parameters were measured such as root length, root fresh and dry weights per plant (g).

**Flowering growth characters**

Flowering growth parameters were measured such as; inflorescence diameter (cm), flowering duration (day), number of inflorescences per plant, inflorescence longevity on the plant and inflorescence fresh weight (g; all fully opened inflorescences per plant before the beginning of fading stage were used), and inflorescence dry weight (g) were estimated according to Elkinany (2016).

**The experimental design and statistical analysis**

The experiments were designed as a split plots design with three replicates (Snedecor and Cochran, 1967). Where, the three varieties of gaillardia were arranged as the main plots, and the synthetic cytokinins concentrations were considered as sub-plots. Data were analyzed by Statistical Analysis Systems (CoStat, 2008) and the means were compared by Tukey multiple comparison post-hoc test at 0.05 probability.

**RESULTS AND DISCUSSION**

**Vegetative characters**

Data in Table (2) showing the main effects of the two studied factors (Three varieties of gaillardia and different levels of synthetic cytokinins) on plant growth parameters of gaillardia plants during the two growing seasons of 2015/2016 and 2016/2017.

Regarding the main effect of three gaillardia varieties on plant growth parameters, data in Table (2) indicated that the three gaillardia varieties significantly differed in their vegetative growth parameters. Pulchella variety showed the highest mean values of plant height, number of branches per plant, leaf area, shoot fresh weight and dry weights per plant, root length and root fresh and dry weights per plant in both seasons. However, there was no significant difference between the two gaillardia varieties “Pulchella and Mesa yellow” in plant height during the first season, in number of branches per plant in both season and root length in the second season. Moreover, there was no significant difference among the three varieties of gaillardia “Pulchella, Mesa Yellow and Lorenziana” in leaf area, shoot fresh weight per plant and root fresh weight per plant in the second season. The detected differences among the three tested varieties could be attributed to their genetic features.

Concerning the main effect of different rates of synthetic cytokinins (BAP and kinetin) on plant growth parameters, data in Table (2) indicated that, spraying gaillardia plants with benzyl amino purine (BAP) and kinetin in general significantly increased vegetative growth parameters compared to control treatment. Spraying plants with BAP at 100 ppm gave the highest mean values of plant height, number of branches per plant, leaf area, shoot fresh and dry weights per plant during both seasons compared to the control treatments. However, there was no significant difference between the two concentrations of BAP (50, and 100 ppm) in number of branches per plant and leaf area in both seasons. On the other hand, spraying with kinetin significantly increased root growth parameters i.e. root length, root fresh weight per plant and root dry weight per plant in both seasons compared to the control treatment.

Results also indicated that the low concentration of kinetin (25 ppm) was more effective than the high concentration of kinetin (50 ppm) in increasing root growth parameters. However, there was no significant difference between the two concentrations of kinetin (25 and 50 ppm) for leaf area in the first season, shoot dry weight per plant in the second season and root fresh and dry weights per plant in the second season.

Generally, the superior influence of benzyl amino purine (BAP) treatments on stimulating the vegetative growth parameters may be due to the role of BAP in stimulating cell division and elongation (Krug et al., 2006, Mazher et al. 2011, and Sadak et al., 2013), which leads to stimulation of primordial production and partially intermodal elongation on the apex (Kumari, 2017), which reflected in the increase of plant height. Cytokinins play an important role in counteracting or eliminating the apical dominance and stimulating the release of axillary buds from apical dominance (Sachs and Thimmann, 1964, 1967; Tamas, 1995; Arteca, 1996 and Menaka et al., 2018) which lead to increment in number of branches per plant.
Table 3: The main effect of C. versicolor and Mi. and BAP on plant growth parameters of Philodendron plants during 2015/2016 and 2016/2017 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>N. of branches</th>
<th>Plant height (cm)</th>
<th>Laminar length (cm)</th>
<th>Leaf area (cm²)</th>
<th>Root length</th>
<th>Root fresh mass</th>
<th>Root dry mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>8</td>
<td>600</td>
<td>380</td>
<td>200</td>
<td>120</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>200 ppm C. versicolor</td>
<td>10</td>
<td>700</td>
<td>450</td>
<td>250</td>
<td>150</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>400 ppm C. versicolor</td>
<td>12</td>
<td>800</td>
<td>500</td>
<td>300</td>
<td>200</td>
<td>70</td>
<td>40</td>
</tr>
<tr>
<td>600 ppm C. versicolor</td>
<td>15</td>
<td>900</td>
<td>600</td>
<td>350</td>
<td>250</td>
<td>80</td>
<td>50</td>
</tr>
</tbody>
</table>

Legend:
- A: Different letters indicate significant difference at P<0.05 level of significance.

Cytokinins are considered a growth control hormones, which promote protein synthesis, cell division, enlargement, cell number and nutrient mobilization (Zhao et al., 2010 and Bairwa and Mishra, 2017). When exogenous applications of Cytokinins are made, they promote cell expansion (Miller, 1956) which leads to increasing the leaf area. The general increase in leaf area as a result of BAP treatments is in agreement with the findings of Reda et al., (2010) on chamomile plant, Henschke et al., (2015) on Helleborus Orientalislam ‘Red Hybrids’, Mansour et al., (2016) on Conocarpus erectus L. Plants, Mara (2017) on Echinacea Hybrids and Mohamed (2017) on aster plant.

The increment in the shoot fresh weight could be explained through the role of cytokinin in stimulating xylem differentiation and vascular strand development, which lead to more absorption of water and nutrients from the soil, which was reflected in more growth, as mentioned by Sorokin and Thimann (1964). These results are in harmony with those obtained by Eid and Abou-Leila (2006) on Coroton plant, Abdel El-Aziz (2007) on Codiaeum variegatum L., Ghatas (2015) on Hemerocallis aurantiaca and Neetu and Singh (2016) on gladiolus. Similar increases in the dry weight of shoot as a result of BAP treatments have been reported by Mazrou (1992) on Datura innoxia plants, Zaghloul (1998) on Codiaeum variegatum and Cordyline terminalis and Mansour et al., (2016) on Conocarpus erectus L. plants.

The positive effect of kinetin on stimulating the root growth parameters may be due to accumulation of greater photosynthates which leading to better growth parameters (El-Keltawi and Croteau, 1987) and the role of kinetin in stimulation of the cell division, enlargement and number (Schmulling, 2002 and Khalighi et al., 2005) which leading to increase root length and number of offsets and then increasing root growth parameters. Our results are in harmony with those of Sardoei et al., (2013) on Aloe barbadensis, Aser et al., (2015) on Gladiolus Cv. Red Candyman, Hembrom and Singh (2015) on Lilium, Ghatas (2015) on Hemerocallis aurantiaca and El-Bably and Rashed (2017) on Clivia miniata.

The interaction effect between the three gaillardia varieties and different levels of BAP and kinetin on plant growth parameters were significant during both seasons (Table 3). The statistical analysis revealed that the highest mean values of plant height recorded at the combined treatment of the three gaillardia varieties “Pulchella, Mesa Yellow and Lorenziana” with 100 ppm BAP treatment. The combined treatment of Pulchella variety with 100 ppm BAP treatment recorded, generally, the highest mean values of number of branches per plant, leaf area, shoot fresh and dry weights in both seasons compared to the control treatment. However, the highest mean values of root length were obtained when Lorenziana cultivar sprayed with 25 ppm kinetin in both seasons. On the other hand the combined treatment which included Pulchella variety with 25 ppm kinetin recorded the highest mean values of root fresh and dry weights, in the both seasons. The 100 ppm BAP level increased number of branches per plant, leaf area, shoot fresh weight and shoot dry weight of Pulchella variety by (62.14 and 81.11%), (15.85 and 20.12%), (35.3% and 38%) and (78.38% and 86.67%) over than the control treatment for the first and second seasons, respectively. Also, 25 ppm kinetin level, increased root fresh and dry weights of Pulchella variety by (48.8% and 56.52%) and (94.6% and 119.44%) over than the control treatment for the first and second seasons, respectively.

**Flowering growth characters**

Concerning the main effect of the three gaillardia varieties on flower parameters, the gained results presented in Table (4) showed that the three gaillardia varieties significantly differed in inflorescence characters. Lorenziana variety showed highest mean values of the most data recorded i.e. inflorescence diameter, inflorescence fresh and dry weight per plant and inflorescence longevity in both seasons. While, Pulchella variety showed highest mean values of number of inflorescences per plant and flowering duration in both seasons. However, there was no significant difference between the two gaillardia varieties “Lorenziana and Pulchella” in inflorescence diameter in both seasons and “Pulchella and Mesa Yellow” varieties in number of inflorescence per plant in the first season only. The detected difference among three gaillardia varieties could be attributed to their genetic features.

Regarding the main effect of different rates of BAP and kinetin on flowering growth parameters, data in Table (4) indicated in general that, spraying gaillardia plants with kinetin and benzyl amino purine (BAP) significantly increased flowering growth parameters compared to control treatment. The obtained data indicated that spray plants with kinetin gave the highest mean values of inflorescence diameter, number of inflorescence per plant, inflorescence fresh and dry weight per plant, inflorescence longevity and flowering duration.
erecta and Mishra (2017) on African Marigold (Tagetes erecta) are in harmony with those reported by Bairwa obtained results of number of inflorescence per plant with kinetin treatment could be due to delay of photosynthesis from source to sink (Salisbury and Ross, 1974 and Hugar and Nalawadi, 1999). The increment in number of inflorescences per plant with kinetin treatment could be due to delay of photosynthesis from source to sink (Salisbury and Ross, 1974 and Hugar and Nalawadi, 1999). The increased longevity of kinetin-treated inflorescence may be due to its effect on ethylene synthesis processes in the tissue of flowers and decreases the ethylene production within the flowers (Bosse and Van Staden, 1989) and decreasing of protein hydrolytic enzymes activity lipoxygenase (Leshem et al., 1979). Also, it may attributed to its role in decreasing the respiration rate of kinetin-treated flowers (MacLean and Dedolph, 1962). The superior influence of kinetin on increasing flowering duration may be due to the increasing of inflorescence fresh number and inflorescence longevity.

The increased longevity of kinetin-treated inflorescence may be due to its effect on ethylene synthesis processes in the tissue of flowers and decreases the ethylene production within the flowers (Bosse and Van Staden, 1989) and decreasing of protein hydrolytic enzymes activity lipoxygenase (Leshem et al., 1979). Also, it may attributed to its role in decreasing the respiration rate of kinetin-treated flowers (MacLean and Dedolph, 1962). The superior influence of kinetin on increasing flowering duration may be due to the increasing of inflorescence fresh number and inflorescence longevity.

Also, there was no significant difference between the two concentrations of kinetin (25, and 50 ppm) in inflorescence diameter, number of inflorescences per plant, inflorescence fresh weight per plant, inflorescence longevity, flowering duration in both seasons, and inflorescence dry weight per plant in the second season.

Generally, the greater influence of kinetin treatments on stimulating the flowering growth parameters may be due to the role of kinetin in promoting protein synthesis, increasing cell division, enlargement and chlorophyll synthesis (Cheema and Sharma, 1982). Which lead to an increase in flower diameter. These results are comparable with those obtained by El-Bably and Ismaiel (2009) on Strelitzia reginae, Youssef and Ismaiel (2009) on Livia minister plant, Ghatas (2015) on Hemerocallis aurantiaca and El-Bably and Rashed (2017) on Clivia miniata. L. plants, Mara (2017) on Echinacea Hybrids and Mohamed (2017) on aster plant.

Kinetin playing a vital role in promoting protein synthesis, increasing cell division and enlargement and chlorophyll synthesis (Cheema and Sharma, 1982) which lead to an increase in inflorescence diameter and, then increment of inflorescence fresh and dry weights. Results of inflorescence fresh weight and flower dry weight per plant are comparable with those obtained by Youssef (2004) on Streitizia regina, Youssef and Ismaiel (2009) on Livia minister plant, Ghatas (2015) on Hemerocallis aurantiaca and El-Bably and Rashed (2017) on Clivia miniata. L.

Table 4: The main effect of G. varieties and Kin. and BAP on flowering parameters of gaillardia plants during 2015/2016 and 2016/2017 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Inflorescence diameter (cm)</th>
<th>N. of inflorescences / plant</th>
<th>Inflorescence fresh weight/plant (g)</th>
<th>Inflorescence dry weight/plant (g)</th>
<th>Inflorescence longevity (day)</th>
<th>Flowering duration (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
<td>2nd</td>
<td>1st</td>
<td>2nd</td>
<td>1st</td>
<td>2nd</td>
</tr>
<tr>
<td>Gaillardia varieties</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mesa</td>
<td>5.05</td>
<td>5.43</td>
<td>24.33</td>
<td>23.67</td>
<td>2.12</td>
<td>2.25</td>
</tr>
<tr>
<td>Yellow</td>
<td>B</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Pulchella</td>
<td>5.91</td>
<td>5.79</td>
<td>24.40</td>
<td>25.60</td>
<td>2.38</td>
<td>2.57</td>
</tr>
<tr>
<td>Lorenziana</td>
<td>5.70</td>
<td>5.87</td>
<td>15.00</td>
<td>14.47</td>
<td>3.6</td>
<td>3.88</td>
</tr>
</tbody>
</table>

Different levels of Kin. and BAP

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Inflorescence diameter (cm)</th>
<th>N. of inflorescences / plant</th>
<th>Inflorescence fresh weight/plant (g)</th>
<th>Inflorescence dry weight/plant (g)</th>
<th>Inflorescence longevity (day)</th>
<th>Flowering duration (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
<td>2nd</td>
<td>1st</td>
<td>2nd</td>
<td>1st</td>
<td>2nd</td>
</tr>
<tr>
<td>Control</td>
<td>4.47</td>
<td>4.48</td>
<td>17.56</td>
<td>16.44</td>
<td>2.45</td>
<td>2.46</td>
</tr>
<tr>
<td>25 ppm</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>kinetin</td>
<td>6.29</td>
<td>6.58</td>
<td>25.22</td>
<td>25.00</td>
<td>2.94</td>
<td>3.15</td>
</tr>
<tr>
<td>50 ppm</td>
<td>6.16</td>
<td>6.52</td>
<td>23.56</td>
<td>24.33</td>
<td>2.89</td>
<td>3.10</td>
</tr>
<tr>
<td>50 ppm</td>
<td>5.79</td>
<td>5.31</td>
<td>21.56</td>
<td>21.89</td>
<td>2.63</td>
<td>3.05</td>
</tr>
<tr>
<td>BAP</td>
<td>5.08</td>
<td>5.62</td>
<td>18.33</td>
<td>18.56</td>
<td>2.59</td>
<td>2.75</td>
</tr>
<tr>
<td>100 ppm</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>BC</td>
<td>BC</td>
<td>BC</td>
</tr>
</tbody>
</table>

1st and 2nd: first season and second season. Values marked with the same alphabetical letters, do not differ significantly, using Tukey's Honest Significant Difference test at 0.05 level of probability.
<table>
<thead>
<tr>
<th>Variety</th>
<th>Length of Time to Harvest (d)</th>
<th>Plant Height (cm)</th>
<th>Leaf Area (cm²)</th>
<th>Leaf Number</th>
<th>Stomata Density (mm²/cm²)</th>
<th>Leaf Margin Angle (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety A</td>
<td>100 Day Harvest</td>
<td>10.2</td>
<td>2.8</td>
<td>1.4</td>
<td>200</td>
<td>45</td>
</tr>
<tr>
<td>Variety B</td>
<td>90 Day Harvest</td>
<td>11.0</td>
<td>3.0</td>
<td>1.6</td>
<td>250</td>
<td>40</td>
</tr>
<tr>
<td>Variety C</td>
<td>80 Day Harvest</td>
<td>11.5</td>
<td>3.2</td>
<td>1.8</td>
<td>300</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 1: The interaction effect between C. vitilis and Xn and BnP on flowering time during 2015/2016 and 2016/2017 seasons.
The general increase in inflorescence longevity and flowering duration as a result of kinetin treatments is in agreement with the findings of Reda et al., (2010) on chamomile plant, Mara (2017) on Echinacea Hybrids, Mohamed (2017) on Symphyotrichum novi-belgii L. and Abou-El-Ghait et al., (2018) on Dendranthema grandiflorium cv. Art Queen plants.

The effects of interaction between the gaillardia varieties and different levels of BAP and kinetin on flowering growth parameters of gaillardia plants were significant during both seasons (Table 5). The obtained results, generally, revealed that the combined treatment which included Pulchella variety and 25 ppm kinetin gave the highest mean values of inflorescence diameter, number of inflorescences per plant and flowering duration in the both seasons. Whereas, the combined treatment of the Lorenziana variety and either 25 or 50 ppm kinetin presented the highest mean values of inflorescence fresh weight, inflorescence dry weight and inflorescence longevity in both seasons. The estimated percentages increase in inflorescence diameter, number of inflorescences per plant and flowering duration for Pulchella variety were (34.69 and 46.67%), (38.1 and 68.42%) and (19.38% and 18.28%) compared to the control treatment for the first and second seasons, respectively. Whereas, the estimated percentages increase in inflorescence fresh weight, inflorescence dry weight and inflorescence longevity for Lorenziana variety were (24.38, 28.13 and 34.38, 31.25%), (71.43 and 10.53, 7.57%) and (24.38, 28.13 and 34.38, 31.25%), (24.38, 28.13 and 34.38, 31.25%) compared to the control treatment for the first and second seasons, respectively.

CONCLUSIONS

This study recommends, generally, that the interaction between Pulchella variety and either BAP at 100 ppm or kinetin at 25 ppm considered as a best treatment for the production of admirable vegetative and flowering growth of gaillardia plants under the environmental conditions of this study.

REFERENCES


الأخص العربي

دور البنزيل أمينو بيورين والكينتين في تحسيـن نمو وإزهرار ثلاثة أصناف من العـنبر كمـيـر

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المتطلبات في حالة اقتصاد و رغم توفر البنزيل أمينو بيورين والكينتين بشكل طبيعي، فإن استخدامها في عناصر النباتات العكرية كمـيـر

للكدوية في اقتصاد موسـمي الشتاء لعامي 2015/2016 و2017/2018، داخل إحـدى الصوـب

في شكل خاص- محافظة البحرـة- جمهورية مصر العربية. وكان الهدف من البحث هو دراسة تأثـرات توعين

من السيتوكينينيات المخلقة وهـم بنزيل أمينو بيورين بتراكـيز 50 و100 جزء في المليون والكينتين بتراكـيز 25 و50

“Gaillardia pulchella Pulchella, Mesa Yellow and Lorenziana”

مقاسمة بمعاـلـقة الغولترول. صممت الدراسة باستخدام تصميم

القطاعات المتشفقة داخل نظام القطاعات كاملاً العشوائيًّا. وقد أظهرت النتائج المتصلـة علىـا خلال الـموسمين بـشكل

عام أن العنـبر كمـيـر صنف “Pulchella” أظهر أحسن نتائج في صفات النمو المدروـسة كذلك بعض

صفات النمو الزهري والتي منها عدد الأزهار لكل نبتة وطول فترة الإزهرار. بينما قد أعطى الصنف “Lorenziana”

أفضل قطر للزهرة وأفضل وزن رطب ووزن جاف للزهرة وأخيراً أفضل عمر للزهرة. أدى الرش الورقي لنباتات

العنبر كمـيـر بواسطة البنزيل أمينو بيورين والكينتين إلى تحقيق زيادة في صفات النمو الخضري والجذري

و الزهري مقارنة بالكونتول. كما سجل الرش الورقي بواسطة البنزيل أمينو بيورين بتركـيز 100 جزء في المليون

أو الكينتين بتركـيز 5 جزء في المليون أعلى القيم لمعظم الصفات تحت الدراسة. ويمكن اعتبار هذه المعاملة بأنها

المعاملة المثلى لإعطاء أعلى إنتاجيه وأفضل جوده لنباتات العنبر كمـيـر وذلك تحت الظروف البيئية لمحافظة

البحرية أو المناطق الأخرى المماثلة لها.