Study of the dynamics of *Lisianthus exaltatum* leaves number during the vegetation period

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**Abstract**

The need to study the species *Lisianthus exaltatum* comes from the permanent wish to diversify cut flower cultivars and meet the increasing demands of the market. To do so, we need to study the different cultivation technologies of the species *Lisianthus exaltatum* to produce plants with longer stems, with larger flowers and with larger numbers of floral buds in modern greenhouses. This study concerns four cultivars of *Lisianthus exaltatum* cultivated in green house monitored from tie stage of seed to the end of vegetation. We monitored the number of leaves/plant in the four hybrid cultivars (Twinkles Dark Blue, Arena Series Red, Arena Series Rose, and Heidi Salmon) with application of four types of biological fertilizers (Lithovit, Zoldpajzs, Cropmax and Biofluid). The goal of this paper was to evaluate the dynamics of number of leaves in *Lisianthus* and establish the technological requirements per vegetation stages. The weekly increases of leaves number/plant in Twinkles Dark Blue during the vegetation range from 3.5 to 17.3 %, whereas in Arena Series Red range from 2.3 and 6.2 %. The leaves number of Heidi Salmon did not significantly change during the last six weeks of vegetation. The variation of leaves number in Arena Series Rose was characterized by a very slow development in the first six weeks. No significant differences between the treatments with biofertilizers were highlighted, regarding their effects on leaves number in any vegetation phases.

**Key words**

*Lisianthus* *exaltatum* cultivars, leaves number dynamics

**Material and Method**

The material used in the experiment was represented by four hybrid cultivars of the species *Lisianthus exaltatum*: Twinkles Dark Blue, Arena Series Red, Arena Series Rose, and Heidi Salmon.

In the experiments, we used four types of foliar fertilizers: Lithovit (0.5%), Zoldpajzs (0.5%), Cropmax (0.2%) and Biofluid (1%). Application of fertilizers was done by spraying the leaves (foliar application) during vegetation at 14 days interval between treatments. Each fertiliser was applied according to the manufacturer’s directions.

Within the experiment, we monitored plant number of leaves during vegetation comparatively in the four cultivars of *Lisianthus* and the impact of fertilizers on each cultivar.

To monitor this features (number of leaves) in *Lisianthus* cultivars, we counted the number of leaves every 7 days starting with June and until September-October, at the end of flowering. Data were then

Lisianthus is native from the southern United States prairies. It can be grown as potted plant or cut flower. This species requires a sunny climate [6]. When grown in the ground, the Lisianthus is very susceptible to soil diseases such as *Fusarium* sp., *Pythium* sp. ou *Thielaviopsis basicola* [3]. Steam disinfection is recommended before each culture. To overcome this problem, a solution is to grow Lisianthus on substrate [4]. Lisianthus plants grown in rockwool cultures and irrigated with nutrient solutions containing 15 mM N with varying proportions of NH₄⁺ and NO₃⁻ showed that an increase in NH₄⁺-N form increased plant height, number of flowers and leaves, leaf area, and shoot, stem, and leaf dry weight. The results suggest that lisianthus can tolerate high levels of NH₄⁺, probably associated with a higher assimilation of Ca [5].

The need to study the species *Lisianthus* comes from the permanent wish to diversify cut flower cultivars and meet the increasing demands of the market. To do so, we need to study the different cultivation technologies of the species *Lisianthus exaltatum* to produce plants with longer stems, with larger flowers and with larger numbers of floral buds in modern greenhouses [1].
introduced into tables and then interpreted and analysed statistically.

Experiments were carried out in greenhouse conditions at the Experimental Station of the Banat’s University of Agricultural Sciences and Veterinary Medicine Timisoara, Romania, during 2013. The plants were grouped in lots. Each of the four *Lisianthus* cultivars was divided into four lots of plants and each lot was fertilised with a different fertiliser. We thus monitored the response of each cultivar to the four types of foliar fertilisers, which allowed us to interpret the results both individually and comparatively.

Means were compared using least significant difference test [Ciulca, 2006]. The significance of differences was expressed based on letters, being considered as significant the differences between variants marked with different letters.

### Results and Discussions

In terms of the combined effect of the growing period and cultivar on the leaves number, namely the foliage development of each plant during the growing period, it was noted that Twinkles Dark Blue cultivar recorded a 16.85 variation amplitude associated with a 38.48 % variability, while in case of Arena Series Red cultivar the amplitude was 7.27 and the variability 20.32 %.

<table>
<thead>
<tr>
<th>Growing period (days)</th>
<th>Variety</th>
<th>TDB</th>
<th>ASRose</th>
<th>ASRed</th>
<th>HS</th>
<th>( \bar{x} \pm \sigma )</th>
<th>( S_{n_x} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>y15.05d</td>
<td>x20.70c</td>
<td>y15.90c</td>
<td>xy17.50c</td>
<td>17.29±0.26</td>
<td>19.17</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>y17.40cd</td>
<td>x23.15bc</td>
<td>y17.87bc</td>
<td>xy20.15bc</td>
<td>19.64±0.28</td>
<td>18.19</td>
<td></td>
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<tr>
<td>42</td>
<td>yz19.30c</td>
<td>x23.55bc</td>
<td>z18.70bc</td>
<td>xy22.72ab</td>
<td>21.07±0.30</td>
<td>18.26</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>x26.00b</td>
<td>x25.70ab</td>
<td>y20.12ab</td>
<td>x24.32a</td>
<td>24.04±0.41</td>
<td>21.46</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>x27.70b</td>
<td>x27.55a</td>
<td>y21.75ab</td>
<td>y23.27ab</td>
<td>25.07±0.55</td>
<td>27.53</td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>x31.90a</td>
<td>x29.60a</td>
<td>y23.17a</td>
<td>y25.35a</td>
<td>27.51±0.57</td>
<td>26.36</td>
<td></td>
</tr>
</tbody>
</table>

The leaves number/plant in Twinkles Dark Blue cultivar has shown an exponential increase with weekly increases from 3.5 to 17.3 % and a general average of about 6 %. The most intensive development of foliage for this cultivar was observed during the period between 42 to 56 days, followed by a small and insignificantly variation in the next two weeks, so that at the end the growing period was recorded a significant increase of leaves number with a weekly rate of 7.6 %.

The variation of leaves number in Arena Series Rose cultivar was considerably lower than at the previous cultivar, being characterized by a very slow development at the beginning of the growing period, namely in the first six weeks when it was recorded a reduced and insignificant amplitude of this trait. Subsequently after four weeks since monitoring began, it was observed a significant increase of about 6% of the leaves number. In the remaining period of growing the leaves number showed a low and insignificant rate of weekly growth comprised between 3.6 and 4.5 %.

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Table 1

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In Arena Series Rose the leaves number submit a progressive increase associated with some significant deviations especially at the beginning and end of the vegetation period, with an average weekly rate of growth by 5.55 % (Fig. 1). In the case of Twinkles Dark Blue cultivar the weekly increase rate was higher (11.85 %) under a slow variation until 42 days, followed by a significant growth up to 56 days and a small variation in the last phases. The high accuracy for these estimations is argued by the high values of the coefficients of determination ($R^2 = 0.9056-0.9379$).

Regarding the change of leaves number/plant in Arena Series Red cultivar, during the growing period it was found a linear increase with a weekly rate ranging between 2.3 and 6.2 %, which generated a slower development of the foliage. Thus, during the first four weeks the leaves number registered an insignificant increase by 1.97-2.80. In comparison with the baseline leaves number (at 14 days) after 56-84 days statistically ensured increases of 4.22-7.27 were registered.

For Heidi Salmon cultivar, the leaves number exhibits an exponential growth with weekly increase rate from 3.5 to 7.55 % and a general mean of about 4.7 %. The most intensive development of the foliage was observed in the first month at the beginning of the vegetation period, followed by a low and insignificant variation in the next four weeks, so that in the last two weeks of vegetation the cumulative increase of leaves number was about 9 %. Therefore, the leaves number of this cultivar did not significantly changed during the last six weeks of vegetation.
Concerning the variation of this trait in Arena Series Red and Heidi Salmon cultivars it can be noted a progressive increase of leaves number during the study with an average weekly rate of growing of 6.03 % for Arena Series Red and 6.63 % for Heidi Salmon, respectively (Fig. 2). Accordingly, the leaves number did not significantly changed during the first and last vegetation period. As well, it is observed that the initial value of leaves number at 14 days was 15.90-17.50, under a high precision of these estimations ($R^2>0.8377$).

No significant differences between the treatments with biofertilizers were highlighted, regarding their effects on leaves number in any vegetation phases, considering that the variability between treatments fluctuated from 18.19 to 27.53 %.

The variation of leaves number in plants treated with Lithovit submitted amplitude of 8.89 and a 26.22 % variability. The development of foliage was relative slow taking into account that the average weekly rate of growth was 4.3 %, without registering significantly differences between two consecutive phases. Thus, it was observed an alternation of the modification of this trait meaning that usually after a more intensive growing at 28 days (6.8 %) a modification of only 1.6 % was followed in the next 14 days, so that subsequently at 56 days the increase rate was intensified up to 8.3 %, in order to decrease to 1.2 % in the next phase, and so on.

Under the treatment with Zoldpajzs the leaves number showed an exponential increase with weekly growth rate from 2.4 to 9.1 % and a general mean of about 5.2 %. The most intense development of the foliage has been observed at the middle of the vegetation period between six and eight weeks, followed by a low variation of 3.3-4.1 % in the last four weeks of vegetation. Therefore, the leaves number did not significantly changed in the last six weeks of vegetation. For this treatment the amplitude of leaves number between the six phases was 10.67 with a variability of 28.25 %, higher than to the other treatments.

### Table 2

<table>
<thead>
<tr>
<th>Growing period (days)</th>
<th>Lithovit</th>
<th>Zoldpajzs</th>
<th>Cropmax</th>
<th>Biofluid</th>
<th>$\bar{x} \pm s_{\bar{x}}$</th>
<th>$S_{5%}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>x17.58c</td>
<td>x18.13c</td>
<td>x16.65c</td>
<td>x16.80d</td>
<td>17.29±0.26</td>
<td>19.17</td>
</tr>
<tr>
<td>28</td>
<td>x19.98c</td>
<td>x20.20c</td>
<td>x19.05bc</td>
<td>x19.35cd</td>
<td>19.64±0.28</td>
<td>18.19</td>
</tr>
<tr>
<td>42</td>
<td>x20.60bc</td>
<td>x21.15bc</td>
<td>x20.40bc</td>
<td>x22.13bc</td>
<td>21.07±0.30</td>
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</tr>
<tr>
<td>56</td>
<td>x24.03ab</td>
<td>x25.00ab</td>
<td>x22.10ab</td>
<td>x25.03ab</td>
<td>24.04±0.41</td>
<td>21.46</td>
</tr>
<tr>
<td>70</td>
<td>x24.60a</td>
<td>x26.63a</td>
<td>x22.85ab</td>
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<tr>
<td>84</td>
<td>x26.47a</td>
<td>x28.80a</td>
<td>x25.92a</td>
<td>x28.82a</td>
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<td>26.36</td>
</tr>
</tbody>
</table>

$LSD_{5%}=3.98 \quad LSD_{1%}=5.24 \quad LSD_{0.1%}=6.70$

The variation of leaves number in plants treated with Lithovit submitted amplitude of 8.89 and a 26.22 % variability. The development of foliage was relative slow taking into account that the average weekly rate of growth was 4.3 %, without registering significantly differences between two consecutive phases. Thus, it was observed an alternation of the modification of this trait meaning that usually after a more intensive growing at 28 days (6.8 %) a modification of only 1.6 % was followed in the next 14 days, so that subsequently at 56 days the increase rate was intensified up to 8.3 %, in order to decrease to 1.2 % in the next phase, and so on.

Under the treatment with Zoldpajzs the leaves number showed an exponential increase with weekly growth rate from 2.4 to 9.1 % and a general mean of about 5.2 %. The most intense development of the foliage has been observed at the middle of the vegetation period between six and eight weeks, followed by a low variation of 3.3-4.1 % in the last four weeks of vegetation. Therefore, the leaves number did not significantly changed in the last six weeks of vegetation. For this treatment the amplitude of leaves number between the six phases was 10.67 with a variability of 28.25 %, higher than to the other treatments.
Regarding the effects of treatment with Lithovit and Zoldpajzs it is found a nonlinear progressive increase of leaves number during the study associated with an average weekly rate of growth of 6.72 % for Lithovit and 7.32 % for Zoldpajzs, respectively. The linearity of this trait variation under the effect of the two treatments is disturbed by the evolution from the third phase (42-56 days), when significantly changes of this trait were registered. As well, it is observed that the baseline value of leaves number at the beginning of study was 17.58-18.13 under a high accuracy of these estimations (R²>0.92).

For the treatment with Cropmax the leaves number/plant submitted the lowest variability (25.83 %) with amplitude of 9.27. The most intense development of foliage with a weekly increase rate of 7.2 % was observed in the first two phases, followed by a decrease of this rate to 1.7 % between the penultimate two phases, so that at the end of the study a rate of 6.7 % has been registered. In comparison with the leaves number after 14 days, only in the last three phases were recorded significantly variations of this trait.

Concerning the modification of leaves number under the effect of treatment with Biofluid, during the vegetation period it is noted a linear increase with a weekly average ranging from 2.3 to 7.6 %, which generated an average weekly growth of foliage of 6.4 %, higher in the first three periods (6.6-7.6 %). Compared with the baseline leaves number (at 14 days) after 42-84 days statistically ensured increases of 5.33-12.02 were registered.

Under the effect of treatment with Cropmax, this trait submitted a significant increase in the last phase of vegetation associated with low variations at the beginning of this study, on a background of an average weekly rate of growth by 6.87 %, Fo the plants treated with Biofluid the increase rate was higher (8.97 %) than the previous treatment, under progressive variations and similar in trend. The high accuracy for these estimations is argued by de high values of the coefficients of determination (R²=0.945).

Conclusions

1. The leaves number/plant in Twinkles Dark Blue has shown an exponential increase with weekly increases from 3.5 to 17.3 % and a general average of about 6 %;
2. The variation of leaves number in Arena Series Rose was characterized by a very slow development at the beginning of the growing period, namely in the first six weeks when it was recorded a reduced and insignificant amplitude of this trait;
3. In Arena Series Red during the growing period it was found a linear increase with a weekly rate ranging between 2.3 and 6.2 %, which generated a slower development of the foliage;
4. For Heidi Salmon cultivar, the leaves number exhibits an exponential growth with weekly increase rate from 3.5 to 7.55 % and a general mean of about 4.7 %. The leaves number of this cultivar did not significantly change during the last six weeks of vegetation;
5. No significant differences between the treatments with biofertilizers were highlighted, regarding their effects on leaves number in any vegetation phases;
6. For the plants treated with Lithovit the development of foliage was relative slow taking into account that the average weekly rate of growth was 4.3 %, without registering significantly differences
between two consecutive phases. The leaves number of plants treated with Zoldpajzs did not significantly changed in the last six weeks of vegetation.

References

1. Bala, Maria, 2012 – Floricultura generala si speciala, Editura Partos, Timisoara, 321-322;
2. Ciulca, S., 2006 – Metologii de experimentare in agricultura si biologie, Ed. Agroprint, Timisoara;