Andrea Tilly-Mándy (Department of Floriculture and Dendrology, Faculty of Horticultural Science, Corvinus University of Budapest, Hungary, andrea.mandy@uni-corvinus.hu)
Viktória Köbli (Department of Floriculture and Dendrology, Faculty of Horticultural Science, Corvinus University of Budapest, Hungary, viktoria.kobli2@uni-corvinus.hu)
Péter Honfi (Department of Floriculture and Dendrology, Faculty of Horticultural Science, Corvinus University of Budapest, Hungary, peter.honfi@uni-corvinus.hu)
Anna Takács (Department of Floriculture and Dendrology, Faculty of Horticultural Science, Corvinus University of Budapest, Hungary, helsinki@citromail.hu)

Applying biostimulators in cut lily production

Summary

In our study we tested the effect of three biostimulators (Kelpak, Ferbanat L, Pentakeep-V) in cut lily production, under greenhouse conditions, on the Oriental hybrid Lilium 'Rialto' variety. Plants were treated fortnightly for 5 times. The control group was untreated. During the evaluation plant height, number of leaves, leaf length, leaf width, the number and length of flower buds, root weight and chlorophyll content of leaves were measured. In the first part of the research we compared the three chemicals and the results showed that in the case of leaf length and leaf width the treated plants reached significantly lower values compared to the control group. However in the case of plant height, the number of leaves and the number and length of flower buds we obtained better results with Ferbanat L in 2 ml/l concentration, compared to the other biostimulators. Therefore, in the second part of the research we examined Ferbanat L in 1-, 2-, 3- and 4 ml/l concentrations. Again the control group was untreated. Considering the development of the plants we got significantly wider leaves with the 3 ml/l concentration treatment, compared to the control plants. In the case of flower buds 4 ml/l treatment resulted more and significantly longer buds, compared to the control group. In addition, 3 ml/l treatment showed significantly lower chlorophyll content, compared to the other groups.

Keywords: Kelpak, Ferbanat L, Pentakeep-V, biostimulators, Lilium, flower buds

1. Introduction

Cut lilies are greatly appreciated and popular cut flowers not just in Western Europe but in Hungary as well. Since decades they have a stable place in so called "top ten" sales and popularity ranks. The reasons, among other things, are their long vase life, their beauty and their colorful, attractive flowers. Growers like the timing ability of new varieties (Schmidt, 2008). In recent years more hybrid groups are known: Asiatic hybrids, Oriental hybrids, *Lilium longiflorum* varieties, *Lilium-Longiflorum*-hybrids (LA hybrids and LO hybrids), OT hybrids. Oriental hybrids are 80-120 cm high with 1, 3 or 5 fragrant, upward facing flowers, 15-18 cm in diameter. Their forcing time is longer than the Asian hybrids', 110-120 days, the vase life is 1,5-2 weeks (de Hertogh, 1996; Schmidt, 2002). Lilies need moderate light conditions, but from the middle of October to the beginning of March Asiatic hybrids need 24 hours, while Oriental hybrids need 18 hours of supplemental light with 4000 lux intensity. In the summer plants should be protected from strong, direct sunlight to avoid heliosis. In the aspect of culture medium lilies prefer loose structured soil with a lot of air, rich in nutrients and mould. The optimal pH is between 5,5 and 6,5, the salt content is maximum 0,15% (Escher, 1983; Hamrick, 2003; Schmidt, 2002). Lilies need frequent watering but they are sensitive to stagnant water (Nagy, 1972).

In recent years biostimulators are used not just in agriculture but also in the field of horticulture, in modern floriculture: in annual- and pot plant production, in cut flower production and in nurseries. Biostimulators are natural plant growth regulators, containing plant hormones like auxin, cytokinins, gibberellic acid and aminoacids, and phytogenic biologically active substances. Applied in optimal concentration they can increase physiological activity in plants, productivity of the plants, improve quality of the plant and help nutrient intake or efficiency.

Kelpak is made of brown kelp (seaweed), *Ecklonia maxima,* which live in the Atlantic Ocean, at the shores of South Africa. The liquid biostimulator contains 34,3% *Ecklonia maxima* extract, 66,5% water, hydrogen peroxide in 50% dilution, 0,07-0,09% acetic acid preservative. From auxin-like and cytokinin-like natural substances, auxin is dominant (10,7 mg/l), therefore it improves cell elongation and cell growth. The cytokinin content is 0,03 mg/kg (www.kelpak.com). Researches and positive results were observed in recent years mainly in vegetable and fruit growing, on pepper (Arthur et al., 2003), on potato (Jenkins, Mahmood, 2003), on strawberry (Masny et al., 2004) and on apple (North and Wooldridge, 2003). In Hungary Kelpak was applied effectively in nursery, on *Sorbus aucuparia* seedlings (Magyar et al., 2008a) and on apple grafts (Magyar et al., 2008b).

Ferbanat L is a complex, humic acid-based, liquid nano-fertilizer, containing microelements, biologically active substances, amino acids and vitamins. It is produced by a special nanotechnological process with biologically clean organic fertilizer. Researches were made so far in vegetable-, fruit- and cereal growing (www.ferbanat.com).

Pentakeep-V is a recently developed crop promoter, conditioning fertilizer. It was developed in Japan, in 2000. Its main substance is 5-amino-levulic-acid (ALA) the precursor of chlorophyll. It contains 9,5% N, 5,7% Mg, 0,3% Mn, 0,45% B, DTPA-Fe, $ZnSO_4$, $CuSO_4$, dinatrium-molibdenat and 0,3% amino-levulic-acid (Cosmo Seiwa Agriculture Co., Ltd., 2007). Besides vegetable- and fruit growing, many studies and positive results were observed in floriculture. Researches were made in the bulb production of some *Tulipa* (Yoshida et al., 2005), *Lilium* and *Gladiolus* (Krzyminska, 2007) varieties, on potted and cut flower *Chrysanthemum* varieties (Nowak, 2006). In 2001, the producer and distributor of Pentakeep-V, Cosmo Seiwa Agriculture Co., Ltd. made researches on potted *Primula* 'Julian Scarlett' variety and observed 20 days earlier flowering in the case of treated plants. In Hungary Pentakeep-V was used effectively on *Tillandsia usneoides* (Tilly-Mándy et. al. 2010a) and in *Saintpaulia ionantha* production (Tilly-Mándy et. al. 2010b), where the treated plants flowered more than two weeks earlier compared to the control plants.

2. Materials and methods

Our researches were carried out from March 2010 and from June 2011, in the greenhouse of lily grower, dr. Sándor Eke, in Dabas, Hungary. Further experiments and analyses were continued in Corvinus University of Budapest, at the Department of Floriculture and Dendrology. We worked with an Oriental hybrid *Lilium* variety, called 'Rialto', which has fabulous white and fragrant flowers and grows 120-130 cm high. The tip of the petals is crispate and curves back. In both researches the bulbs were imported from the Netherlands, arrived in cooled conditions. They were pre-forced in boxes in a cool chamber and after they reached 4-5 cm high stem they were planted out in the flowerbed, 4-5 cm deep.

In March 2010, in the first experiment three biostimulators, Kelpak, Pentakeep-V and Ferbanat L were applied. Five treatment groups were formed in separate parts of the flowerbed. Each group contained 24 plants. Treatment groups were created as follows:

1. Kelpak in 2 ml/l concentration, by irrigation
2. Pentakeep-V in 0,3 ml/l concentration, by irrigation
3. Ferbanat L in 2 ml/l concentration, by leaf spraying
4. Ferbanat L in 2 ml/l concentration, by irrigation

5. Control group, irrigation with tap water

Treatments and measurements were made five times, fortnightly. During the evaluation plant height, leaf length, leaf width, number of leaves, number of flower buds and flower bud length were measured. In the end of the experiment 5 plants/treatments were selected and we measured the root weight and determined the fresh and dry weight of the leaves and the chlorophyll content of the leaves (Arnon, 1949).

Based on the results of the first experiment, in the second experiment in June 2011, we applied only Ferbanat L biostimulator on the plants, in 4 different concentrations, by irrigation. Treatment groups were formed in separate parts of the flowerbed. Each group contained 24 plants. Five treatments were created as follows:

1. Ferbanat L in 1 ml/l concentration
2. Ferbanat L in 2 ml/l concentration
3. Ferbanat L in 3 ml/l concentration
4. Ferbanat L in 4 ml/l concentration
5. Control group, irrigation with tap water

Treatments and measurements were made five times, fortnightly. During the evaluation plant height, leaf length, leaf width, number of leaves, number of flower buds and flower bud length were measured. In the end of the experiment we determined the chlorophyll content of 5 plants/treatments (Arnon, 1949). In both researches all the other conditions (temperature, light intensity, water supply, air vapour, soil and basic fertilizing) were the same within the whole plant stock in the greenhouse of the company.

Data were statistically analyzed with PASW Statistics 18 program by one way analysis of variance (ANOVA) with random arrangement (α=0,05). Homogenity of variances were tested by Levene-test, comparisons between means were made by Tukey-test.

3. Results and discussion

3.1. The effect of biostimulators on the development and growth of the plants

The results of plant growth and development of the first research can be seen on Table 1.. Lilies in the irrigated Ferbanat L treatment group were significantly higher compared to the ones in the other four groups. In this case it means approximately 5 centimeters in average, which seems like not a big difference but in the production of cut lilies the quality category of a cut flower depends on the length of the stem. The plants treated with sprayed Ferbanat L, Kelpak and Pentakeep-V were almost the same height as the plants in the Control group. In the aspect of leaves, both length and width results were better on the Control plants. Although Ferbanat L treatments gave higher number of leaves, the difference was not significantly better compared to the Control group. In the growing practice of cut lilies besides the flowers, leaves also have important ornamental effects and moreover they influence the productivity of the plant. Root weight was the only parameter where Kelpak treatment showed significantly better result compared to the untreated Control plants.

Table 1: The effect of different biostimulators on the growth and development of *Lilium* 'Rialto' variety, in 2010.

	Plant height (cm)	**Leaf length** (cm)	**Leaf width** (cm)	**Number of leaves** (pcs)	**Root weight** (gr)
Kelpak 2 ml/l	101,92 a	14,28 a	3,87 ab	37,8 a	139,94 b
Pentakeep-V 0,3 ml/l	102,21 a	14,25 a	3,92 ab	42,6 ab	105,78 ab
Ferbanat L irrigated 2 ml/l	106,25 b	14,47 ab	3,95 ab	45,4 b	113,38 ab

Ferbanat L sprayed 2 ml/l	101,31 a	14,28 a	3,78 a	45,2 b	120,84 ab
Control	101,81 a	14,94 b	4,16 b	44,6 ab	91,46 a

Note: Different letters in the same column mean significant differences (p<0,05).

3.2. The effect of biostimulators on the flowering of the plants

Although both Ferbanat L treatments resulted in more flower buds than the Control, Kelpak and Pentakeep-V treated plants, neither of them were significantly different (Table 2.). In the case of the length of flower buds statistically all groups showed same results. Considering the way of application in the case of Ferbanat L, significant differences were not observed in the flowering of plants.

Table 2: The effect of different biostimulators on the flower buds of *Lilium* 'Rialto' variety, in 2010.

	Kelpak 2 ml/l	**Pentakeep-V 0,3 ml/l**	**Ferbanat L irrigated 2 ml/l**	**Ferbanat L sprayed 2 ml/l**	**Control**
Number of flower buds (pcs)	3,8 a	3,8 a	5 a	4,6 a	4,4 a
Length of flower buds (cm)	8,16 a	7,96 a	8,06 a	8,72 a	8 a

3.3. The effect of biostimulators on the chlorophyll content of leaves

Table 3. shows that chlorophyll content of the plants' leaves sprayed with Ferbanat L was the highest compared to the other treatment groups, but statistically no differences could be shown among the groups.

Table 3: The effect of different biostimulators on the chlorophyll content of *Lilium* 'Rialto' variety's leaves, in 2010.

	Kelpak 2 ml/l	**Pentakeep-V 0,3 ml/l**	**Ferbanat L irrigated 2 ml/l**	**Ferbanat L sprayed 2 ml/l**	**Control**
Chlorophyll content (microgr/gr)	1064,42 a	943,01 a	880,05 a	1323,47 a	1156,55 a

3.4. The effect of Ferbanat L on the development and growth of the plants

The development and growth results of the second research are shown on Table 4.. Treatments with different concentrations of Ferbanat L increased significantly neither plant height, nor leaf length, or number of leaves. Significantly wider leaves were measured on the plants treated with 3 ml/l Ferbanat compared to the Control group. 3 ml/l concentration treatment resulted in the highest plants, but the difference is not significant. In the aspect of

plant height, leaf width and number of leaves the lowest average values were measured in the 4 ml/l concentration group.

Table 4: The effect of Ferbanat L on the growth and developing of *Lilium* 'Rialto' variety, in 2011.

	Plant height (cm)	**Leaf length** (cm)	**Leaf width** (cm)	**Number of leaves** (pcs)
Ferbanat L 1 ml/l	101,80 a	14,51 a	3,95 ab	48,2 a
Ferbanat L 2 ml/l	100,60 a	14,57 a	4,06 ab	47,2 a
Ferbanat L 3 ml/l	103,60 a	14,25 a	4,18 b	42,8 a
Ferbanat L 4 ml/l	100,00 a	14,52 a	3,95 ab	41,8 a
Control	103,30 a	14,31 a	3,81 a	46,6 a

Note: Different letters in the same column mean significant differences ($p<0,05$).

3.5. The effect of Ferbanat L on the flowering of the plants

As it can be seen in Table 5., 4 ml/l Ferbanat L treatment resulted in the longest and in the most flower buds compared to the other concentrations and to the Control group. However, significant difference is shown only in the length of flower buds. In average, the fewest and shortest flower buds were measured on the plants of the Control group. As the concentration of the biostimulator was higher, more flower buds were measured.

Table 5: The effect of Ferbanat L on the flower buds of *Lilium* 'Rialto' variety, in 2011.

	Ferbanat L 1 ml/l	**Ferbanat L 2 ml/l**	**Ferbanat L 3 ml/l**	**Ferbanat L 4 ml/l**	**Control**
Number of flower buds (pcs)	4,83 a	5,13 a	5,00 a	5,38 a	4,88 a
Length of flower buds (cm)	10,96 ab	10,58 ab	10,32 a	11,16 b	10,26 a

Note: Different letters in the same column mean significant differences ($p<0,05$).

3.6. The effect of Ferbanat L on the chlorophyll content of leaves

Table 6: The effect of Ferbanat L on the chlorophyll content of *Lilium* 'Rialto' variety's leaves, in 2011.

	Ferbanat L 1 ml/l	Ferbanat L 2 ml/l	Ferbanat L 3 ml/l	Ferbanat L 4 ml/l	Control
Chlorophyll content (microgr/gr)	1142,56 a	1139,73 a	976,06 b	1155,31 a	1135,19 a

Significantly lower chlorophyll content was measured in the leaves of plants, treated with 3 ml/l concentration Ferbanat L compared to the other groups. Plants treated with 1, 2 and 4 ml/l concentration of biostimulator had almost the same chlorophyll content values as plants in the Control group. Comparing the chlorophyll content results of the 2010 and 2011 researches, sprayed Ferbanat L in 2 ml/l concentration provided the highest chlorophyll content (Table 6.).

Bibliography and sources

1. Schmidt, G. 2008: Liliom. In: Tillyné Mándy A., Honfi P. (ed.): Növényházi dísznövénytermesztés. BCE Kertészettudományi Kar, Budapest. p. 250-258.
2. Schmidt, G. 2002. Növényházi dísznövények termesztése. Mezőgazda Kiadó. Budapest. p. 325-335.
3. de Hertogh, A. 1996. Holland Bulb Forcer's Guide. International Flower Bulb Centre and The Duch Bulb Exporters Association, The Netherlands, p. 79-109.
4. Escher, F. 1983. Schnittblumenkulturen. Verlag Eugen Ulmer, Stuttgart, p. 385-400.
5. Hamrick, D. 2003. Crop Culture A-Z. In: Ball Redbook 17th Edition, Volume 2. Crop Production. Illinois USA. Publishing. p. 487-506.
6. Nagy, B. 1972. Vágott virágok. Mezőgazda Kiadó. Budapest. p. 56-59.
7. Jenkins, P.D., Mahmood, S. 2003. Dry matter production and partitioning in potato plants subjected to combined deficiencies of nitrogen, phosphorus and potassium. Wales UK. Annals of Applied Biology. 143(2):215-229.
8. Arthur, G. D., Stirk, W. A., van Staden, J. 2003. Effect of a seaweed concentrate on growth and yield of three varieties of Capsicum annuum. South African Journal of Botany, 69(2):207-211.
9. Masny, A., Basak, A., Zurawicz, E. 2004. Effects of foliar application of Kelpak SL and Goëmar BM 86® preparation on yield and fruit quality in two strawberry cultivars. Skierniewice, Poland. Journal of Fruit and Ornamental Plant Research Vol.12.
10. North, M., Wooldridge, J. 2003. Number and concentration of calcium nitrate plus Kelpak® sprays for control of bitter piti n 'Braeburn' apple fruit. South African Journal of Plant and Soil. 20(3):141-145.
11. Magyar, L., Barancsi, Z., Dickmann, A., Hrotkó, K. 2008a. Application of biostimulators in nursery. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Horticulture. 65(1)/2008, pISSN 1843-5254; eISSN 1843-5394. p. 515.
12. Magyar, L., Barancsi, Z., Hrotkó, K. 2008b. Improved feathering by combined application of BA and biostimulators. International Workshop on Sustainable Fruit Growing. Pitesti, Romania. Editura INVEL-Multimedia, Bucureşti, p. 68-71.
13. Yoshida, R., Ohta, E., Iwai, K., Tanaka, T., Okada, H. 2005. Effects of liquid fertilizer containing 5-aminolevulinic acid on thickening growth in tulip bulbs. Proceedings of the 32nd Annual Meeting of the Plant Growth Regulation Society of America, Newport Beach, California, USA, 24-27 July, 2005. Vol.32. p. 91-94.

14. Krzyminska, A. 2007. Influence of Pentakeep-V on yield and quality of tulip, allium, lilium bulbs and gladiolus corms. http://www.agroniwa.pl/files/07_praga_2007_dr_krzyminska.pdf
15. Nowak, J. 2006. The effect of Pentakeep-V on growth and flowering of chrysanthemum (Chrysanthemum x grandiflorum (Ramat.) Kitam.). http://www.agroniwa.pl/files/budapeszt_2006__prof._nowak.pdf
16. Tilly-Mándy, A., Honfi, P., Marczika, A., Köbli, V., Palásti, Gy. 2010a. The Effect of Bioactive Agents on the Growth and Chlorophyll Content of Tillansia usneoides L. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Horticulture, 67(1)/2010, Print ISSN 1843-5254; Electronic ISSN 1843-5394. p. 388-393.
17. Tilly-Mándy, A., Honfi, P., Stefanovits-Bányai, É., Mosonyi, I. D., Köbli, V., Hrotkó, K. 2010b. The effect of 5-aminolevulinic-acid (ALA) on the development of *Saintpaulia ionantha*. International Journal of Horticultural Science 16.(5) p. 33-36.
18. Arnon, D.I. 1949. Copper enzymes in isolated chloroplasts. Polyphenoloxidase in Beta vulgaris. PlantPhysiology. 24 (1): 1-15.
19. www.kelpak.com Official webpage of Kelpak
Activity: http://www.kelpak.com/index.php?option=com_content&view=article&id=4&Itemid=2
The source:
http://www.kelpak.com/index.php?option=com_content&view=article&id=2%3Athe-source&catid=1%3Aat-a-glance&Itemid=1
20. www.ferbanat.com Ferbanat L Official webpage, Ferbanat L Distributing Office
What is Ferbanat L: http://www.ferbanat.com/index_eng.asp?id=27
Application results: http://www.ferbanat.com/index_eng.asp?id=41
What are the influences of Ferbanat L: http://www.ferbanat.com/etkileri_eng.asp?id=28
21. Cosmo Seiwa Agriculture Co., Ltd. 2007. Pentakeep-V Overview, Pentakeep-V How to Use, Pentakeep-V Catalogue, The effect of Pentakeep-V to flowers
http://www.pentakeep-world.com/english/pentakeep_v/index.html
http://www.pentakeep-world.com/english/pentakeep_v/pdf/PENTAKEEP-V_omote.pdf
http://www.pentakeep-world.com/english/pentakeep_v/pdf/PENTAKEEP-V_howtouse.pdf
http://www.pentakeep-world.com/english/pentakeep_v/pdf/caseofuse01.pdf