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EFFECT OF BENZYLADENINE ON FLOWER AND LEAF YIELD OF CALLA LILY (*ZANTEDESCHIA* SPRENG.)

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Abstract

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Research was conducted in the years 2008-2010. The cultivars used in the study were as follows: 'Albomaculata' derived from *Zantedeschia albomaculata* /Hook./ Baill., 'Black Magic' coming from an inter-species hybrid of *Zantedeschia elliottiana* /Wats./ Engl. x *Z. macrocarpa* Engl. and 'Mango' derived from *Zantedeschia* sp. Bulbs 15-18 cm in circumference in the cultivars Black Magic and Mango and 20+ cm in cultivar Albomaculata, with leaf buds 0.5-1.5 cm in length, were planted into 18-cm pots into a medium consisting of peat with a pH of 6.2, enriched with a slow-release fertiliser Osmocote Plus (3-4M) in the amount of 3 g per dm^3 and mixed with fresh, shredded pine bark at a rate of 3:1 (v:v). Before planting, the bulbs were soaked for 30 minutes in water solutions of benzyladenine (BA) at concentrations of 0, 100, 350 and 600 mg/dm^3. The application of BA at these concentrations resulted in increasing 2-3 times the flower yield, staying neutral towards flower quality. Additionally, the application did not influence the yield of leaves. The leaves, however, showed higher greenness index and protein content.

Key words: ornamental plants, benzyladenine, flowering, index of leaves greenness, protein

Introduction

The increasing customer interest in cut flowers of calla lilies with colourful spathes does not involve appropriate reaction in Polish flower production. The calla lily is grown on small areas due to the fear of low profitability, as the bulbs reproduction, carried abroad, is very costly. The calla producers do not seem to be attracted by the high price of cut flowers, either, because the yield of calla cultivars with colourful spathes is on a low level. The low profit drown from selling cut flowers does not meet the costs of establishing a plantation.

In order to improve the flowering of the calla lily, we use gibberellic acid (Funnell and Tjia, 1988; Denis et al., 1994, Funnell et al., 1992; Corr and Widmer, 1991; Janowska and Krause, 2001).

Although it affects positively the yield of many cultivars, it also delays flowering and deteriorates the quality of flowers (Janowska and Krause, 2001; Janowska and Schroeter, 2002; Janowska and Zakrzewski, 2006). That is why it is highly purposeful to search for new methods which will enhance the flowering of valuable cultivars but will not decline their quality.

The main purpose of the conducted research was to estimate the effect of benzyladenine applied in a bulbs-soaking solution on the quality and yield of flowers and leaves of the cultivars Albomaculata, Black Magic and Mango.

Material and Methods

Research was conducted in the years 2008-2010. The cultivars used in the study were as follows: 'Albomaculata' derived from *Zantedeschia albomaculata* /Hook./ Baill., 'Black Magic' coming from an inter-species hybrid of *Zantedeschia elliottiana* (Wats.) Engl. x *Z. macrocarpa* Engl. and 'Mango' derived from *Zantedeschia* sp.

Bulbs 15-18 cm in circumference in the cultivars Black Magic and Mango and 20+ cm in cultivar Albomaculata, with leaf buds 0.5-1.5 cm in length, were planted into 18-cm pots on 10th May 2008, 12th May 2009 and 15th May 2010 into a medium consisting of peat with a pH of 6.2, enriched with a slow-release fertiliser Osmocote Plus (3-4M) in the amount of 3 g per dm^3 and mixed with fresh, shredded pine bark at a rate of 3:1 (v:v). Before planting, the bulbs were soaked for 30

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minutes in water solutions of benzyladenine (BA) at concentrations of 0, 100, 350 and 600 mg/dm^3.

The experiment consisted of 12 treatments (BA concentration x cultivar). In each year of the study, one combination consists of 15 plants, five plants in three replications.

The plants, grown in a plastic tunnel, were fed starting with the fifth week of cultivation. Every 10-14 days, solutions of mixed fertilisers, Peters Professional and brown Superba, were applied at a concentration of 0.2%. At the start of vegetation, when the leaves were fully developed, lime saltpetre at a concentration of 0.2% was foliar applied once.

The length of peduncles and spates was measured. The yield of flowers developing from a single bulb and the fresh flower weight were determined. In calla lily a "flower" is a stipulated term, conventionally simplified, related to an inflorescence embedded on a peduncle called a spadix which is surrounded by a spathe.

The yield of leaves growing from a single bulb was calculated as well as their greenness index, in SPAD units, employing a SPAD-502 Chlorophyll Meter (Gregorczyk and Raczyńska, 1997; Gregorczyk et al., 1998). In addition, protein content in the leaves was quantified applying Bradford's (1976) method. 2 ml of the solution of Coomassie Brillant Blue G-250 (CBB) in 85% orthophosphoric acid was added to 100 µl of a diluted extract, with the extraction in a phosphorate-potassium buffer (pH 7.0). After 10 minutes the absorbance of light was measured at a wavelength of 595 nm. The protein content was measured basing on the curve plotted for albumin.

The data, given as means from the three years of research, were processed applying a two-factor analysis of variance. The means were grouped employing Duncan's test at $\alpha = 0.05$ significance level.

Results

The flower yield of the cultivars studied was claimed to depend significantly on both – the BA concentration and the cultivar (Table 1). Regardless of the BA concentration, the two cultivars Black Magic and Mango harvested on a similar level giving on average 2.4 and 2.7 flowers per a single bulb respectively. 'Albomaculata' showed the most abundant flowering producing on average 4.0 flowers per bulb. 100-600 mg/dm^3 BA concentration increased flower yield significantly regardless of the cultivar. The flowering reinforcement was considerable as a single bulb produced 100% more flowers on average.

Comparing the quality of flowers of the cultivars under study, it was ascertained that the only factor which affected it was the cultivar (Table 1). 'Black Magic' produced the most impressive flowers with the grandest weight, while 'Albomaculata' produced the smallest ones with the least abundant weight.

The analysis of the leaves proved that the yield of leaves depended only on a cultivar (Table 2). 'Albomaculata' was characterized by the most abundant yield per bulb while 'Black Magic' and 'Mango' produced 6.1 and 3.9 leaves on average, respectively (Table 2).

The index of leaf greenness was affected by two factors - 100-600 mg dm^{-3} BA treatment and a cultivar (Table 2). The lowest index of leaf greenness was recorded in 'Albomaculata', while the highest in 'Black Magic' irrespective of the BA concentrations. Benzyladenine, in the concentrations applied, affected index of leaf greenness so that all the cultivars under study developed leaves with a significantly higher index. In addition, the highest index of leaf greenness was achieved while dipping rhizomes in 350 and 600 mg/dm^3 BA concentration.

The protein content in leaves was proved to depend significantly on two factors - BA concentration and a cultivar (Table 2). The least abundant protein content characterised the leaves of 'Mango' – irrespective of the BA concentrations. 'Black Magic' and 'Albomaculata' showed a similar protein content. Irrespective of the cultivar, the application of BA escalated the protein content in proportion to its concentration.

Discussion

The outcomes of the current study argue that calla lilies with colourful spathes yield on a low level as it was obtained – depending on the cultivar - barely 0.8 – 1.9 flowers per bulb despite planting the large bulbs only. The use of 100-600 mg/dm^3 benzyladenine to dip bulbs improved 2-3 times the flower yield of the cultivars under study.

Benzyladenine as a stimulant of ornamental plants flowering was mentioned for the first time in the 1970s. Goh (1977; 1979) was one of the researchers who observed a larger number of flowers formed in inflorescences of orchids from the genera *Aranda* and *Dendrobium* after BA application. The confirmation of the similar effect of BA on flowering was achieved by Ramina et al. (1979) who studied *Bougainvillea* as well as by Yonemura and Higucki (1978) who observed *Schlumbergera truncata*. Meanwhile the research carried recently proved a positive BA influence on flowering of *Zantedeschia aethiopica* 'Green Goddes' (Luria et al., 2005), *Liatris spicata* 'Alba' (Pogroszewska and Sadkowska, 2008b), *Campanula persicifolia* 'Alba' (Pogroszewska and Sadkowska, 2008a), *Astilbe* x *arendsii* 'Amethyst' (Pogroszewska and Sadkowska, 2007), and orchids from the genera *Phalenopsis* and *Doriotaenopsis* (Blanchard and Runkle, 2008). BA application, however, gives not always favorable effects on flowering. Ngamau (2001) did not attain an augmentation of the yield of *Zantedeschia aethiopica* 'Green Goddes' after BA application as well as Janowska et al. (2009) of *Anemone coronaria* 'Sylphide'.

Table 1
Yield and quality of flowers of *Zantedeschia* depending on concentration of benzyladenine and cultivar

Concentration of BA, mg/dm^3	Cultivar			Mean for concentration of BA
	Black Magic	Mango	Albomaculata	
Yield of flowers				
0	0.8	1.9	1.9	1.5
100	2.8	3.0	5.1	3.6
350	3.3	3.0	4.3	3.5
600	2.5	2.1	4.7	3.2
$LSD_{0.05}$ for interaction		0.29		
Mean for cultivar	2.4	2.7	4.0	
$LSD_{0.05}$ for means		0.94		1.12
Length of inflorescence peduncle, cm				
0	32.9	26.3	24.6	27.9
100	32.4	28.6	20.3	27.1
350	32.7	28.3	25.3	28.8
600	29.1	25.4	27.8	27.4
$LSD_{0.05}$ for interaction		2.33		
Mean for cultivar	31.8	27.2	24.5	
$LSD_{0.05}$ for means		2.67		-
Length of spathe, cm				
0	9.3	9.8	8.6	9.2
100	10.7	9.3	8.6	9.5
350	10.4	9.8	8.7	9.6
600	10.6	9.1	8.6	9.4
$LSD_{0.05}$ for interaction		0.41		
Mean for cultivar	10.2	9.5	8.6	
$LSD_{0.05}$ for means		0.56		-
Weight of flower, g				
0	20.0	16.5	10.9	15.8
100	20.0	18.2	10.0	16.0
350	20.3	18.4	11.3	16.6
600	20.1	16.0	9.6	15.2
$LSD_{0.05}$ for interaction		0.37		
Mean for cultivar	20.1	17.3	10.4	
$LSD_{0.05}$ for means		1.12		-

The results of the experiment do not show any influence of benzyladenine on the quality of calla lily flowers marked by the length of peduncles and spathes as well as their weight.

According to the research, however, the influence of BA on flowering depends on a species. Janowska et al. (2009) claim that the elongation of peduncles of *Anemone coronaria* 'Sylphide' is inhibited after BA application while 50 mg/mg^3. BA concentration in particular causes development of flowers with a smaller diameter. Ryu and Lee (1993) studying *Aster tataricus* and Leclerc et al. (2006) researching *Hemerocallis* sp. also proved unfavourable effect of BA application on the length of shoots.

In the present research benzyladenine is claimed not to affect the yield of leaves in the cultivars Black Magic, Mango and Albomaculata , but to cause a higher greenness index and a higher protein content. According to the few studies on the effect of BA on the leaf development conducted so far it appears that the response depends on the species. The inhabiting effect of BA on leaf development is reported by Janowska et al. (2009) in *Anemone coronaria* 'Sylphide' as well as Wang and Boogh-ert (1987) in *Syngonium podophyllum*. The reliance is not, however, reported by Marcinek and Hetman (2006) in *Hedera helix* 'Brokamp'. The available literature does not offer much infor-

Table 2
Yield and quality of leaves of *Zantedeschia* depending on concentration of benzyladenine and cultivar

Concentration of BA, mg/dm^3	Cultivar			Mean for concentration of BA
	Black Magic	Mango	Albomaculata	
Yield of leaves				
0	5.8	4.2	22.8	10.9
100	6.2	3.3	22.1	10.5
350	7.0	3.7	22.7	11.1
600	5.4	4.6	25.8	11.9
$LSD_{0.05}$ for interaction		1.16		
Mean for cultivar	6.1	3.9	24.1	
$LSD_{0.05}$ for means		2.14		-
Index of leaf greenness, SPAD				
0	53.2	55.1	48.0	52.1
100	55.0	59.0	53.3	55.8
350	63.1	61.2	51.5	58.6
600	55.1	62.2	54.7	57.7
$LSD_{0.05}$ for interaction		2.54		
Mean for cultivar	56.6	59.4	51.9	
$LSD_{0.05}$ for means		2.78		2.83
Protein content, mg /g^1 FW				
0	16.4	14.2	15.4	15.3
100	22.6	19.4	21.7	21.2
350	29.1	27.0	30.5	28.9
600	40.0	38.8	42.4	40.4
Mean for cultivar	25.3	24..9	27.5	
$LSD_{0.05}$ for interaction		2.15		3.11

mation about the influence of BA on the intensity of leaf colour. Janowska (2010) indicates a positive effect of BA application on the index of greenness in the *Zantedeschia* 'Mango' and 'Pink Pimpernel'. The research on vegetables showed the inhibiting effect of BA application on chlorophyll degradation in inflorescences of broccoli (Clark et al., 1994; Down et al., 1997) and in leaves of Brussels sprouts (Zink, 1961).

Not only do proteins regulate life processes of plants but they are also a part of building components of cells and tissues. They are responsible for the majority of biochemical reactions in living organisms. The higher level of proteins after BA treatment corresponded with the expectations and proved the results of the studies on useful plants (Klambt, 1976; Takegami and Yoshiba, 1977; Prusiński and Borkowska, 2002).

The positive results of the studies induce researchers to extend the interests on other calla lily cultivars. As a result, it might encourage Polish producers to increase the area of their cultivation.

Conclusion

In conclusions, 100-600 mg/dm^{-3} BA concentrations improves 2-3 times the flower yield of the cultivars Black Magic, Mango and Albomaculata staying neutral towards flower quality. Benzyladenine does not affect the leaf yield in calla lily cultivars under study. The BA treatment increases the index of leaves greenness and the protein content.

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