Effect of mycorrhization on the flowering of the *Zantedeschia albomaculata* /Hook./ Baill. cv. Albomaculata

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Abstract

Janowska B., Andrzejak R., Kosiada T., Trelka T., Frąszczak B., 2013. **Effect of mycorrhization on the flowering of the *Zantedeschia albomaculata* /Hook./ Baill. cv. Albomaculata**. Hort. Sci. (Prague), *40*: 126–130.

The study involved the application of a top dressing of a multicomponent Peters Professional fertiliser at concentration of 100 and 200 mg/l in the amount of 100 ml/plant, once every 7 days regardless of the fact whether the rhizomes had been mycorrhized before or not. Mycorrhization caused an increase in the quality of flowers, as expressed by peduncle length and their yield in *Zantedeschia albomaculata* cv. Albomaculata at both levels of top dressing, which shows that it is possible to reduce the top dressing dosage to a concentration of 100 mg/l. Mycorrhization had a favourable effect on the accumulation of nitrogen and manganese in the leaves of the calla lily. In mycorrhized plants the mean nitrogen content in 12 leaves ranged between 5.35 and 5.55% d.w. Mycorrhized plants accumulated more manganese in19 their leaves irrespective of the level of top dressing.

Keywords: ornamental plants; yield; quality; micro- and macroelements; Peters Professional fertilizer; endomycorrhizal fungi

Ecological aspects of flower production force producers of ornamental plants to limit the application of mineral fertilisers in favour of organic ones. However, this is not always possible because the mineralisation of nitrogen and phosphorus from organic fertilisers is often too slow to meet the requirements of plants (Falkowski et al. 2009). So far few studies were devoted to nutrition problems of the calla lily with colourful spathes grown for cut flowers. Funnell (1993) recommends liquid feeding with fertilisers where the N:P:K proportion is 15:7:14, with nitrogen at 100–200 mg/l. Slow-release fertilisers applied at 2–4 g/l are equally beneficial.

It is mycorrhiza that can be an alternative in the cultivation of ornamental plants as it has a beneficial effect on the uptake of some elements (N, P, Zn, Cu) (Ryan, Angus 2003; Neumann, George 2005). It is estimated that about 80% of flowering

plants live in this type of symbiosis (Falkowski et al. 2009). Mycorrhiza results in the earliness and abundance of flowering in many species of ornamental plants (Nowak 2004; Falkowski et al. 2009). The available literature offers no information about the cultivation of the calla lily in symbiosis with fungi. Henceforth the present study offers an assessment of the flowering and level of nutrition of the spotted calla cv. Albomaculata after the application of endomycorrhizal fungi.

MATERIAL AND METHODS

Research was conducted in the years 2009–2011. The cv. Albomaculata derived from *Zantedeschia albomaculata* /Hook./ Baill. was used in the study. Rhizomes of more than 20 cm in circumference, with leaf buds 0.5–1.5 cm in length, were planted into 20-cm pots on 15 May 2009, 15 May 2010 and 15 May 2011 into a medium consisting of peat with a pH of 6.2, enriched with a slow-release fertiliser Osmocote Plus (3–4M) (A.M. Leonard, Piqua, USA) in the amount of 3 g/l and mixed with fresh, shredded pine bark at a rate of 3:1 (v:v).

The study involved the application, of a top dressing of a multicomponent Peters Professional (Scotts) fertiliser (Scotts, Marysville, USA) at concentration of 100 and 200 mg/l in the amount of 100 ml per plant once every 7 days.

Endomycorrhizal fungi of the genera *Glomus* (*G. aggregayum*, *G. mosseae, G. intraradices*, *G. etunicatum*, *G. clarum*) and *Gigaspora* (*G. margerita)* were applied in the form of spores a week after planting in the amount of 100 propagation units per plant.

The experiment consisted of 6 treatments (a concentration of nutrition × mycorrhization). In each year of the study, one combination consists of 15 plants, five plants in three replications.

The length of peduncles and spathes was measured and the yield of flowers developing from a single rhizome was determined. In the calla lily a "flower" is a conventional simplified term used to describe the inflorescence on a peduncle – a spadix – surrounded by a spathe.

For chemical analyses, leaves from the central part of the leaf rosette were taken. An average sample consisted of 15 leaves from each treatment. They were dried at a temperature of 45–50°C and then ground. To determine the totals of nitrogen, phosphorus, potassium, calcium and magnesium, they were mineralised in concentrated sulphuric acid. The determinations of the nutrient content were performed using the following methods: total N – the distillation method after Kjeldahl on a Parnas-Wagner apparatus (Chemland, Stargard Szczeciński, Poland), P – the colorimetric method employing ammonium molybdate (after Schillak), and K, Ca, Mg – atomic absorption spectrometry (AAS). To determine total iron, manganese, zinc and copper, the leaves were mineralised in a mixture of nitric and perchloric acids (3:1, v:v), and for sodium, in concentrated sulphuric acid (Kamińska et al. 1972). After the mineralisation, Na, Fe, Mn, Zn, and Cu contents were determined by means of the AAS method (on a Carl Zeiss Jena apparatus – AAS-3N, Analityk Jena, Jena, Germany).

The results, presented as the average of three years of research, were processed statistically with the help of a two-factor analysis of variance by means of Statistica ver. 8.0 software (StatSoft, Kraków, Poland). Uniform groups were determined with the Newman-Keuls test.

RESULTS AND DISCUSSION

The intensity of flowering of the calla lily with colourful spathes depends on the cultivar and the size of its rhizomes, but even the planting of rhizomes of very great dimensions does not guarantee an abundant harvest. This was proved by the research involving the cv. Albomaculata, in which the flower yield increased only after mycorrhization. An additional advantage of the symbiosis with fungi was an improved quality of flowers as expressed by the length of the peduncle (Table 1). This favourable response of the cultivar to the symbiosis suggests mycorrhiza should be an alternative to gibberellic acid in boosting bloom abundance. In the calla lily gibberellic acid is employed in the form of a solution for rhizome soaking. While its effectiveness is unquestionable (Funnell, Tjia 1988; Corr, Widmer 1991; Funell et al. 1992; Dennis et al. 1994; Janowska, Krause 2001; Janowska, Schroeter 2002; Janowska, Zakrzewski 2006), its application is highly inadvisable from the point of view of the plants health because it contributes to the spread of a bacterial disease very dangerous to the calla lily – the soft rot of rhizomes. An addition of mycorrhizal fungi to the substratum stimulated flower bud induction, probably because endomycorrhizal fungi produce growth regulators, including those from the gibberellin group (Matysiak 2009).

Table 1. Abundance and quality of the flower yield (number of flowers from 1 rhizome) in the spotted calla cv. Albomaculata after the application of mycorrhizal fungi and various levels of top dressing

Concentration of Peters Professional (mg/l)	Mycorrhization	
	–	+
Yield of flowers		
0	3.0	3.0
100	3.2	10.0
200	3.1	10.2
$LSD_{0.05}$ for interaction	1.26	
Length of flower stem (cm)		
0	30.0	30.0
100	30.0	42.6
200	34.6	41.4
$LSD_{0.05}$ for interaction	2.87	
Length of spatha (cm)		
0	10.0	10.0
100	10.0	10.5
200	11.0	10.5
$LSD_{0.05}$ for interaction	–	

The study proved an additional advantage resulting from the introduction of mycorrhization to calla lily cultivation, which was the fact that differences in the amount of top dressing applied did not matter (Table 1). This is highly favourable in ecological terms because it allows cutting down on fertiliser dosages. Better growth of mycorrhized plants in the conditions of limited fertilization or a nutrient deficiency was observed by Lee and George (2005) in the cucumber and by Matysiak (2007) in rhododendrons.

It was shown that there was an intensive accumulation of nitrogen in the leaves of plants grown without the symbiosis with fungi and top-dressed with the lower concentration of fertiliser and very low nitrogen content when the top dressing was applied at the higher concentration (Table 2). As follows from the few reports published to date, intensive nitrogenous fertilization facilitates the infection of plants with the bacterium *Erwinia carotovora* susbp. *carotovora* – the cause of the soft rot of rhizomes, a disease very dangerous for *Zantedeschia* (Van Leeuveen 2002). In mycorrhized plants the mean nitrogen content in leaves ranged between 5.35 and 5.55% d.w. (Table 2). Owing to the absence of information about optimum levels of this element in calla lily leaves in the available literature, it is impossible to make any comparisons in this species. However, it may be presumed that they are relatively high because, as Digat and Lamaire (1993) report for *Pelargonium,* which is a species with much higher nutritional requirements, the optimum ranges of N content in its leaves are 3.30–4.76% d.w. and 3.89 to 4.50% d.w. On the basis of the results obtained in the present study, it can be inferred that mycorrhiza had a stimulating effect on the intensity of nitrogen uptake, because the leaves of mycorrhized plants contained from 5.35 to 5.55% of this element.

Differences in top dressing were found to have an effect only on the phosphorus content in leaves (Table 2). Irrespective of mycorrhization, signifi-

Table 2. Content of macroelements in leaves of the spotted calla cv. Albomaculata after the application of mycorrhizal fungi and various levels of top dressing (% d.w.)

Concentration of Peters Professional (mg/l)	Mycorrhization	
	–	+
Nitrogen		
0	5.20	5.20
100	6.73	5.35
200	5.18	5.55
$LSD_{0.05}$ for interaction	1.13	
Phosphorus		
0	0.49	0.49
100	0.45	0.44
200	0.54	0.53
$LSD_{0.05}$ for interaction	0.04	
Potassium		
0	4.30	4.30
100	4.47	3.89
200	4.14	4.41
$LSD_{0.05}$ for interaction	0.14	
Calcium		
0	0.79	0.79
100	0.79	0.80
200	0.79	0.78
$LSD_{0.05}$ for interaction	–	
Magnesium		
0	0.24	0.24
100	0.23	0.23
200	0.23	0.22
$LSD_{0.05}$ for interaction	–	

cantly higher levels of this element were recorded in the leaves of plants top-dressed with fertiliser at the higher concentration. Nowak (2009) reports that in *Callistephus chinensis* cv. Milady mycorrhization has no effect on P content in the leaves of plants grown with this element at a higher concentration in the medium.

It was shown that the content of potassium in leaves depended significantly on mycorrhization only (Table 2). Significantly more K, irrespective of the level of top dressing, was found in the leaves of non-mycorrhized plants. The greatest amounts of potassium were accumulated in the leaves of plants which had not been mycorrhized and top-dressed with the lower concentration of fertiliser, and those which had been mycorrhized and top-dressed with its higher concentration. The smallest amounts of potassium were found in the leaves of plants mycorrhized and top-dressed with the lower fertiliser dosage. The fact that mycorrhiza had no effect on K content in leaves was demonstrated by Nowak (2009) in *Callistephus chinensis* cv. Milady.

Table 3. Content of metallic microelements and sodium in leaves of the spotted calla cv. Albomaculata after the application of mycorrhizal fungi and various levels of top dressing (mg/kg d.w.)

Concentration of Peters Professional (mg/l)	Mikoryzation	
	–	+
Iron		
0	41.70	41.70
100	40.00	40.10
200	43.40	45.90
$LSD_{0.05}$ for interaction	–	
Manganese		
0	67.00	67.00
100	68.93	78.85
200	74.80	77.60
$LSD_{0.05}$ for interaction	3.53	
Zinc		
0	29.97	29.97
100	30.30	25.90
200	29.65	32.38
$LSD_{0.05}$ for interaction	–	
Copper		
0	6.55	6.55
100	6.54	6.93
200	6.57	6.63
$LSD_{0.05}$ for interaction	–	
Sodium		
0	0.03	0.03
100	0.06	0.03
200	0.02	0.05
$LSD_{0.05}$ for interaction	–	

The factors under analysis were not observed to have any effect on the content of calcium and magnesium in calla lily leaves (Table 2). The fact that mycorrhiza had no influence on Ca content in the leaves of *Callistephus chinensis* cv. Milady was reported by Nowak (2009), however, she reported that it had a favourable effect on the Mg content.

On comparing the content of microelements and sodium in leaves of the calla lily, it was found that the factors under study had only an effect on manganese content (Table 3). The amount of this element in plants which had been mycorrhized and fertilized at the higher concentration was significantly higher. Mycorrhized plants accumulated more manganese in their leaves irrespective of the level of top dressing, which suggests that it is possible to reduce its dosage in the cultivation of the calla lily.

Zinc, like molybdenum, boron and aluminium, are considered to be a potentially dangerous elements. As follows from a study by Walker et al. (2003), thanks to mycorrhiza its content drops in the leaves of *Betula lenta.*

The results of the research conducted encourage further efforts at assessing the effect of mycorrhiza on the flowering of the calla lily.

CONCLUSION

In conclusion, mycorrhization caused an increase in the quality of flowers, as expressed by peduncle length, and their yield in *Zantedeschia albomaculata* cv. Albomaculata at both levels of top dressing, which shows that it is possible to reduce the top dressing dosage to a concentration of 100 mg/l. Mycorrhization had a favourable effect on the accumulation of nitrogen and manganese in the leaves of the calla lily.

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Received for publication January 10, 2013
Accepted after corrections March 1, 2013

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