THE EFFECTS OF COCOPEAT AND FERTILIZATION ON THE GROWTH AND FLOWERING OF ORIENTAL LILY 'STAR GAZER'

Jadwiga Treder

Research Institute of Pomology and Floriculture
Pomologiczna 18, 96-100 Skierniewice, POLAND
e-mail: jtreder@insad.pl

(Received December 7, 2007/Accepted May 5, 2008)

A B S T R A C T

Cocopeat was evaluated as a growing medium for Oriental lily forcing. Fertilization levels were adjusted to accomplish this purpose. The mixture of sphagnum peat, bark and sand (5:1:1 v/v) was used as a control medium. The main macronutrients N, P, and K in nutrient solutions were as follows: I - control, without fertilizers, II - N, P and K at 150, 48 and 240 mg dm^{-3}, III - N, P and K at 240, 48 and 240 mg dm^{-3}, IV - only N at 240 mg dm^{-3}. Lilies grown in cocopeat flowered earlier, had better quality expressed as higher fresh and dry weight of flowers and leaves, had longer flower buds, better root system and lower bulb depletion between planting and flowering, compared to these grown in the control substrate. Higher N level (240 mg dm^{-3}) in nutrient solution (fertilization level III and IV) gave taller and heavier plants in both growing media. Plants grown in cocopeat had significantly better developed root system. The number of bulb roots and total root length were 34% and 118% higher in cocopeat than in control medium, respectively.

Key words: coconut coir dust, cut flowers, growing media, lily forcing, root system

INTRODUCTION

Lilies could be forced in various kinds of soils, however growing medium should be well aerated, with good water holding capacity, good drainage and good physical structure. In heavy soils without enough drainage, the development of root system is suppressed and plants are more susceptible to soil borne diseases (Beattie and White, 1992). Due to high lily requirements for growing medium, growers very often use boxes instead of planting bulbs directly into the soil on greenhouse beds. Sphagnum peat with different additives, such as soil, sand or bark is usually used in different proportions.

Since the last few years cocopeat, also known as coir dust or coconut mesocarp, has been considered as

a renewable sphagnum peat substitute for the use in horticulture (Yau and Murphy, 2000; Pickering, 1997). Cocopeat has good physical properties, high total pore space, high water content, low shrinkage, low bulk density and slow biodegradation (Evans et al., 1996; Prasad, 1997). The results of many experiments revealed that cocopeat used alone, or as a component of soil medium, is suitable for roses (Blom, 1999), gerbera (Labeke and Dambre, 1998), many poted plants (De Kreij and Leeuven, 2001; Meerow, 1995; Noguera et al., 1997; Pickering, 1997; Treder and Nowak, 2002) and also for vegetables. Due to usuall high initial level of potassium and sodium in cocopeat, the fertilization program should be adjusted carefully to plant requirements.

The aim of this study was to examine the effect of cocopeat as a growing medium on the lily growth and quality during forcing.

MATERIAL AND METHODS

Lily bulbs 'Star Gazer' (precooled 12 weeks before planting at 5°C) with 13-14 cm in circumference were planted in 10-liter containers, 5 bulbs per each, and forced in a greenhouse from September till December. Two types of growing media were used: cocopeat and, as a control, a mixture of peat, composted pine bark and sand (5:1:1 v/v). Before planting, cocopeat was amended with ammonium nitrate, monoammonium phosphate, ferrous sulfate, cuprous sulfate, magnesium sulfate and ammonium molybdate at: 0.5, 0.25, 0.06, 0.02, 0.2 and 0.001 g dm^{-3}, respectively. Control medium was amended with 1 g dm^{-3} of commercial fertilizer (13.6 N, 2.8 P, 15 K; 2.7 Mg plus trace elements, Azofoska, Poland). The main macronutrients (N, P, K) in nutrient solutions, in different fertilization treatments were as follows: I – control, only water without fertilizers, II – N, P and K at 150, 48 and 240 mg dm^{-3} from complete fertilizer Peters (15:11:29), III – N, P and K at 240, 48 and 240 mg dm^{-3} from complete fertilizer Peters (15:11:29) and calcium nitrate, IV – only N at 240 mg dm^{-3} from calcium nitrate. Plants were fertigated every 3-4 days, depending on growing conditions.

At flowering, the number of days from planting to flowering was calculated, plants were harvested and their height, the number and length of buds, plant fresh and dry weight were measured. Dry weight of aerial plant parts, dissected into flower buds, leaves and stem were determined after drying them in an oven at 70°C for 72 hours.

Two weeks after flowering the bulbs were lifted, cleaned and weighed; bulb roots were washed and evaluated using HP Scan Jet IIC Scaner with a program – Delta-T SCAN Image Analysis System. Bulb depletion was calculated as a ratio of weight losses between planting and flowering to bulb weight at planting and expressed as percentage. The results of root evaluation were presented as a mean of all fertilization treatments.

The experiment was a split plot design with growing media as a main plot and fertilization levels being the

subplots. Each treatment consisted of three replicates with 15 plants (3 containers) in each replication. The statistical analysis of the treatments was tested using analysis of variance and means were compared by Duncan's multiple range test.

RESULTS AND DISCUSSION

The results showed that cocopeat, used as a growing medium during lily forcing, had beneficial effect on plant growth, flowering and root development. Lilies grown in cocopeat flowered earlier, on average on 1.6 days before plants grown in control substrate (Tab. 1). An interaction was found between growing media and fertilization. Plants in control medium flowered at the same time in all fertilization levels. However, in cocopeat control and fertilization treatment III plants flowered earlier. The early flowering of lilies in cocopeat could be the results of faster plant development due to good root system and better heat properties of cocopeat. The earlier flowering, about 8-7 days, was also observed in *Pelargonium* grown in cocopeat (Treder and Nowak, 2002).

Plant height was affected significantly by both experimental factors: growing media and fertilization. The shortest lily stems were obtained in treatment without fertilization. The length of stems was 69.8 cm and 70.4 cm on control growing medium and on cocopeat, respectively. Higher N and Ca level in nutrient solution (fertilization III and IV) gave taller plants. De Hertogh (1989) and Miller (1992) reported that Easter and Oriental lilies are heavy feeders, and low nutrition (especially N and Ca) during forcing usually reduced plant quality. Poor growth of lilies grown without fertilization corresponds to previous results on Oriental lily obtained by Treder (2000).

Cocopeat used as a growing medium decreased slightly bulb depletion. Fertilization, however, did not influence this parameter. The interaction was found between growing media and fertilization. The decrease in bulb weight during initial few weeks after planting is the result of hydrolysis of storage compounds (mainly starch) in mother bulb scales. This happens to support stem growth until the assimilates from new, developed leaves ensure plant growth (Miller and Langhans, 1989). Simultaneously to the mother bulb scale depletion during forcing, the growth increase o of daughter scale, developing on the stem base, is observed. Unfavorable growth condition, e.g. insufficient light level during forcing and insufficient fertilization could also increase mother bulb depletion and suppress development of new daughter scales (Miller and Langhans, 1989; Treder, 2003).

The fresh weight of flower buds and leaves were affected by both experimental factors (Tab. 2). Plants grown on cocopeat accumulated more fresh weight in these organs than plants grown in control medium. The highest fresh weight of flowers was obtained on cocopeat according to II and III fertilization treatment; 32.5 g and

Table 1. The influence of growing medium and fertilization on flowering time, plant height, fresh weight and bulb depletion of lily 'Star Gazer'

Growing medium	Fertilization – N, P and K content in nutrient solution [mg dm^{-3}]	Number of days from planting to flowering	Plant height [cm]	Fresh weight of aerial parts [g]	Bulb depletion between planting and flowering [%]
Peat, sand and bark (5:1:1 v/v)	I Control	99.0 c	69.8 a	59.4 ab	65.8 a
	II 150;48;240	98.6 c	71.9 ab	62.6 ab	72.3 b
	III 240;48;240	98.9 c	73.3 ab	63.5 bc	68.0 ab
	IV 240; 0; 0	98.7 c	73.7 abc	64.5 bc	72.5 b
Cocopeat	I Control	96.2 a	70.4 ab	57.9 a	68.9 ab
	II 150;48;240	98.2 bc	74.1 bc	67.1 cd	65.5 a
	III 240;48;240	96.9 ab	77.7 c	70.8 d	67.3 a
	IV 240; 0; 0	98.3 bc	77.5 c	65.8 cd	67.2 a
Significance level					
Growing media		**	**	*	*
Fertilization		NS	**	**	NS
Interaction		*	NS	NS	*

Means followed by the same letter do not differ significantly according to Duncans test ($p \leq 0.05$)
**, *, NS significant at $p \leq 0.01$; 0.05 and not significant, respectively

Table 2. The influence of growing medium and fertilization on fresh and dry weight partitioning of lily 'Star Gazer'

Growing medium	Fertilization - N, P and K content in nutrient solution [mg dm^{-3}]	Fresh weight [g $plant^{-1}$]			Dry weight [g $plant^{-1}$]		
		flower buds	leaves	stem	flower buds	leaves	stem
Peat, sand and bark (5:1:1 v/v)	I Control.	23.3 a	17.2 a	12.2 a	2.62 a	2.21 a	1.70 a
	II 150;48;240	28.4 bc	20.4 ab	16.8 b	3.35 b	2.62 ab	2.39 cd
	III 240;48;240	27.2 bc	20.8 ab	15.6 b	3.21 b	2.73 b	2.29 cd
	IV 240;0; 0	27.7 bc	22.1 bc	17.7 b	3.52 b	2.94 b	2.59d
Cocopeat	I Control.	25.7 ab	19.4 a	12.1 a	2.70 a	2.23 a	1.68 a
	II 150;48;240	32.5 d	21.6 ab	15.3 b	3.19 b	2.53 ab	2.07 ab
	III 240;48;240	32.2 d	23.4 bc	16.3 b	3.56 b	2.77 b	2.21 cd
	IV 240; 0; 0	30.5 cd	24.1 c	17.1 b	3.43 b	2.69 b	2.34 cd
Significance level							
Growing media		**	*	NS	NS	NS	*
Fertilization		**	**	**	**	**	**
Interaction		NS	NS	NS	NS	NS	NS

For explanation, see Table 1

Table 3. Number and total length of bulb roots of lily 'Star Gazer' at flowering as influenced by growing medium

Treatment	Number of bulb roots [no plant^{-1}]	Total length of bulb roots [cm plant^{-1}]
Control medium – peat, sand, bark (5:1:1 v/v)	3.91	63.5
Cocopeat	5.25	138.7
Significance level	*	***

***, * significant at $p \leq 0.001$; 0.05, respectively

32.2 g, respectively. The fresh weight of stems was not influenced by the type of growing medium. Dry weight of flower buds and leaves were not affected by the growing medium. However, stem dry weight was lower on cocopeat. Irrespectively on the growing medium, the smallest fresh and dry weight of all organs had the plants grown without fertilization. In case of gerbera, Labeke and Dambre (1998) observed that plants in cocopeat had periodically shorter stems than plants on rockwool however, their weights were higher.

The bulb root system was significantly better developed in lilies grown on cocopeat (Tab. 3). The number of roots and total root length were 34% and 118% higher on cocopeat than in the control treatment, respectively. It seems that good physical and biological conditions in cocopeat had positive effect on root development. Beneficial effect of cocopeat on root system was observed on *Osteospermum* cuttings (Nowak, 2004), salvia, viola (Pickering, 1997) and *Impatiens* (Smith, 1995).

In the present study lily bulbs of size 13-14 cm in circumference gave about 80% of plants with 3 flower buds on a stem. The influence of experimental factors, growing media and fertilization, on the length of the first flower bud was evaluated on plants with three flower buds. Lilies grown on cocopeat had longer flower buds than on control medium, irrespectively of fertilization level (Fig. 1A). The shortest flower buds had plants grown without fertilization on both growing media. Plants on II fertilization level had flower buds of 10.2 and 10.9 cm long on control medium and cocopeat, respectively. Higher N level in nutrient solution, (fertilization III and IV) resulted in longer flower buds. As expected, the longest first flower buds had plants with two buds and the shortest plants with four buds (Fig. 1B). Irrespectively of the number of flower buds on a plant, longer buds had plants grown on cocopeat than on control growing medium.

Flower bud length of lilies depends on the variety, growing conditions and the number of buds on the stem (De Hertogh, 1989). The lily flower buds on plants bearing

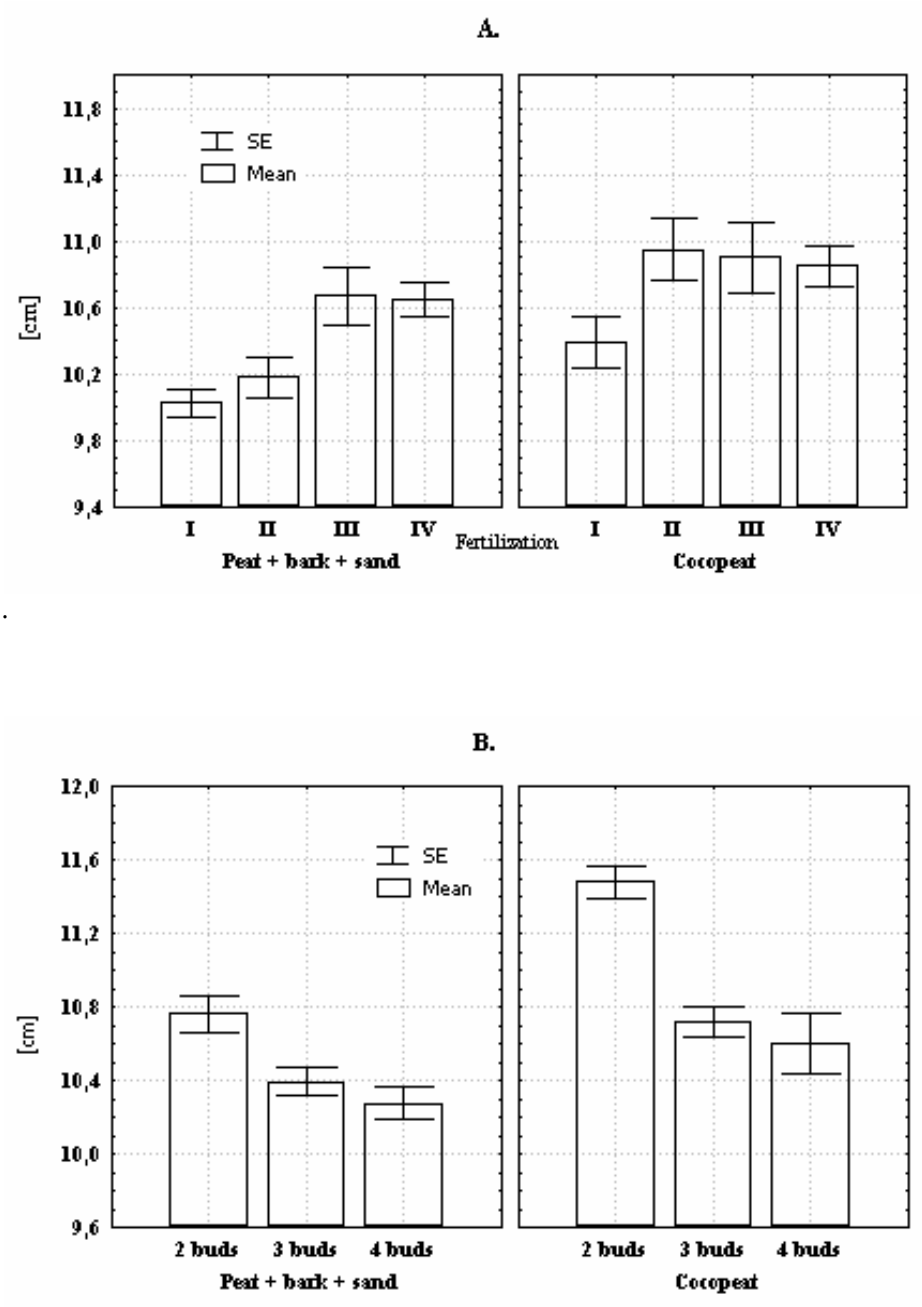

Figure 1. The length of first flower bud of 'Star Gazer' as affected by growing medium and fertilization, compared within plants with 3 flower buds (A) and compared with respect to growing medium and bud number on plant (B)

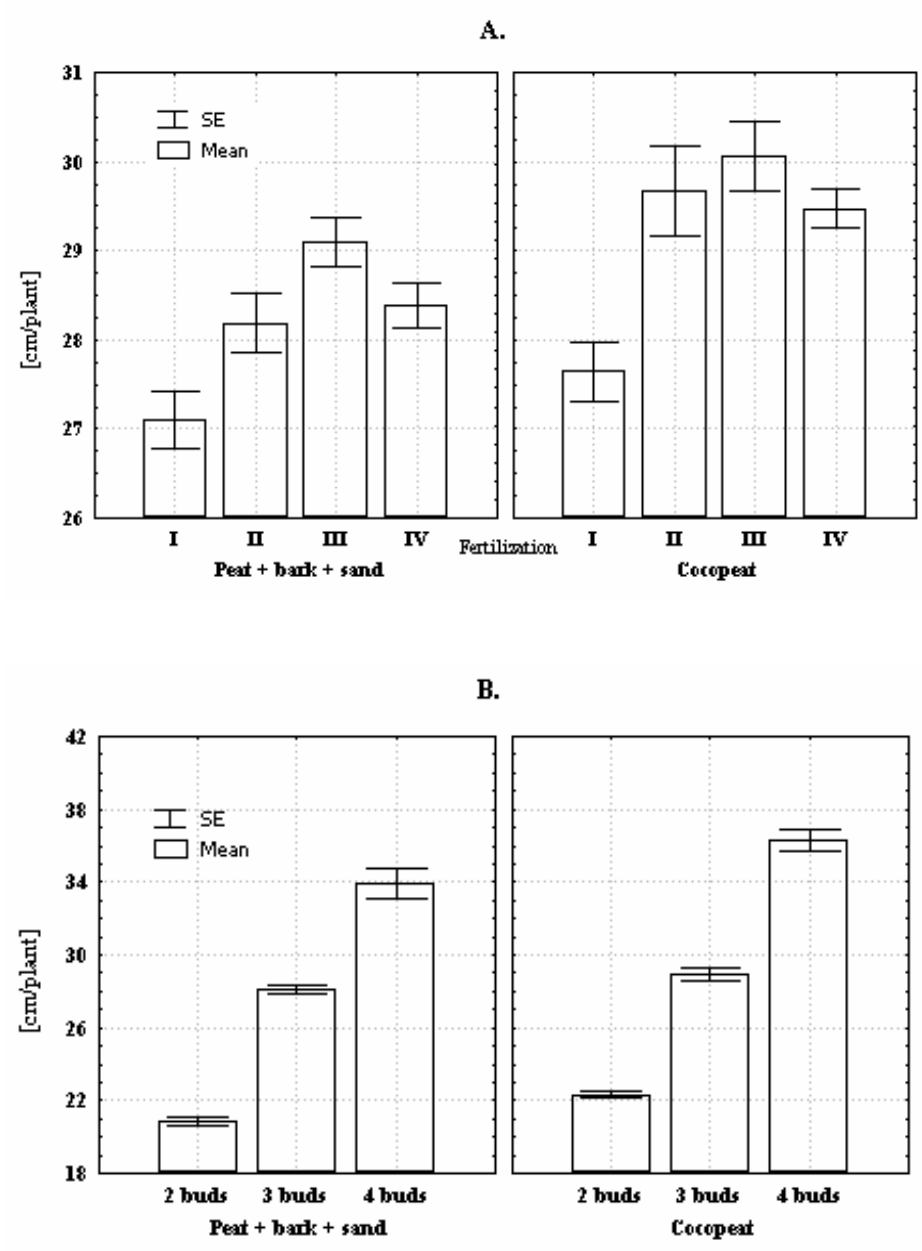

Figure 2. Total length of flower bud of 'Star Gazer' as affected by growing medium and fertilization, compared within plants with 3 flower buds (A) and compared with respect to growing medium and bud number on plant (B)

more flowers are usually shorter. The results of the present study confirm that the length of the first flower bud decreased with increasing bud number on stem (Fig. 1). The experimental factors, growing medium and fertilization, influenced the length of the first bud and total bud length on plant, counted on plants with three buds (Fig. 2A). As expected, the shortest flower buds had plants grown without fertilization on both growing media. Longer flower buds had plants grown on cocopeat. Increased N levels in nutrient solution resulted in greater total length of flower buds on both growing media. Treder (2000) also reported that the length of the first flower bud of three oriental varieties: 'Casa Blanca', 'Olympic Star' and 'Star Gazer' increased at higher levels of N, K and Mg in nutrient solution. In the present study plants receiving N only from calcium nitrate (fertilization IV) had shorter buds than plants receiving complete nutrient solution from Peters (15:11:29) and calcium nitrate (fertilization III). It seems that plants receiving complete nutrient solution benefit more from good growing medium properties than plants fertilized with N and Ca only, even if the cocopeat itself contained some K quantities before planting.

In conclusion, presented results showed that cocopeat, due to suitable physical, chemical and biological properties could be used successfully in lily forcing with an appropriate fertilization program. In spite of satisfying results in lily production using cocopeat, the quality of the plants grown in peat, bark and sand were still satisfactory. Erwin (1998) reported that in case of *L. longiflorum* forcing media such as cocopeat and rice hulls have produced equal or superior crops compared to many existing commercial media Because cocopeat on its own and without any additives, is more expensive than sphagnum peat, the medium containing 25 to 50% of cocopeat could also give desirable results in lily forcing.

REFERENCES

Beattie D.J., White J.W. 1992. Lilium – hybrids and species. In: De Hertogh A.A. and Le Nard M. (eds.), The Physiology of Flower Bulbs. Elsevier, Amsterdam.

Blom T.J. 1999. Coco coir versus granulated roockwool and 'arching' versus traditional harvesting of roses in a recirculating system. ACTA HORT. 481: 503-507.

De Hertogh A.A. 1989. Holland bulb forcers guide. Eds. 4. Intern. Flower Bulb Centre, Hillegom, Holland.

De Kreij C., Leeuven G.J.L. 2001. Growth of pot plants in treated coir dust as compared to peat. COMMUN. SOIL SCI. PLANT ANAL. 32: 2255-2265.

Erwin J.E. 1998. Easter lily production. MINN. COMM. FLOWER GROW. BULL. 47 (5): 1-10.

Evans M.R., Konduru S., Stamps R.H. 1996. Source variation in physical and chemical properties of coconut coir dust. HORTSCIENCE 31: 965-967.

Labeke Van M.C., Dambre Van P. 1998. Gerbera cultivation on coir with recirculating of the nutrient solution: a comparison with roockwool culture. ACTA HORT. 458: 357-362.

Meerow A.W. 1995. Growth of two tropical foliage plants using coir dust as a container medium amendment.. HORTTECHN. 5: 237-239.

Miller W.B. 1992. Easter and hybrid lily production. Timber Press, Inc. Portland Oregon.

Miller W.B., Langhans R.W. 1989. Reduced irradiance affects dry weight partitioning in Easter lily. J. AM. SOC. HORT. SCI. 114: 306-309.

Noguera P., Abad M., Puchades R., Noguera V., Martinez J. 1997. Physical and chemical properties of coir waste and their relation to plant growth. ACTA HORT. 450: 365-374.

Nowak J. 2004. The effect of rooting media and CO_2 enrichment, P – nutrition and micorrhizal inoculation on rooting and growth of *Osteospermum*. ACTA HORT. 644: 589-593.

Pickering J.S. 1997. An alternative to peat. THE GARDEN 122: 428-429.

Prasad M. 1997. Physical, chemical and biological properties of coir dust. ACTA HORT. 450: 21-29.

Smith C. 1995. Coir: a viable alternative to peat for potting. HORTICULTURIST 4: 25-28.

Treder J. 2000. Wpływ nawożenia na wzrost i kwitnienie lilii orientalnych oraz zawartość składników mineralnych. (Influence of fertilization on growth, flowering and mineral nutrient content of Oriental lilies) ZESZ. NAUK. INST. SADOWN. KWIAC. 7: 375-380 (In Polish with English abstract).

Treder J., Nowak J. 2002. Zastosowanie podłoży kokosowych w uprawie roślin rabatowych.. ZESZ. PROBL. POST. NAUK ROL. 485: 335-358 (in Polish with English abstract).

Treder J. 2003. Effects of supplementary lighting on flowering, plant quality and nutrient requirements of lily 'Laura Lee' during forcing. SCI. HORT. 98: 37-47.

Yau P.Y., Murphy R.J. 2000. Biodegraded cocopeat as a horticultural substrate. ACTA HORT. 517: 275-278.

WPŁYW PODŁOŻA KOKOSOWGO I NAWOŻENIA NA WZROST I KWITNIENIE LILII ORIENTALNEJ ‘STAR GAZER’

Jadwiga Treder

S T R E S Z C Z E N I E

Badano wpływ podłoża kokosowego oraz nawożenia na wzrost i kwitnienie lilii orientalnej ‘Star Gazer’ podczas pędzenia. Podłoże kontrolne stanowiła mieszanka torfu, piasku i kory (5:1:1 v/v). Nawożenie zróżnicowano następująco: I – kontrola bez nawożenia, II – N, P i K odpowiednio w dawkach 150, 48 i 240 mg dm^{-3}, III – N, P i K w dawkach 240, 48 i 240 mg dm^{-3}, IV – tylko N w dawce 240 mg dm^{-3}. Lilie uprawiane w podłożu kokosowym zakwitły wcześniej oraz miały lepszą jakość: większą świeżą i suchą masę, dłuższe pąki kwiatowe oraz lepiej rozwinięty system korzeniowy w stosunku do roślin uprawianych w podłożu kontrolnym. Zwiększenie zawartości azotu w pożywce nawozowej (kombinacja III i IV) spowodowało, że uzyskano lilie o dłuższych i cięższych pędach. System korzeni cebulowych lilii uprawianych w podłożu kokosowym był lepiej rozwinięty: liczba i długość korzeni odpowiednio większe o 34 i 118% w porównaniu z podłożem kontrolnym, a także mniejszy ubytek masy wyjściowej cebul.

Słowa kluczowe: podłoże kokosowe, kwiaty cięte, podłoża, pędzenie lilii, system korzeniowy