

Use of Organic or Inorganic Substrates for Reducing the Use of Peat and Improving the Quality of Bulbs and Inflorescences in Asiatic Lily

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Abstract

Peat, mainly imported from Northern and Eastern Europe, is the basic constituent of organic substrates commonly utilized in the cultivation of ornamental plants in pots or in benches. Recently, the supply of peat is hampered by environmental and economical constraints. Thus, it is necessary to find new materials to replace peat. With the aim to evaluate the effectiveness of inorganic or organic materials in floriculture, several experiments were conducted at the CRA-VIV Pescia, Italy. Previous trials, carried out on *liatris*, tulips, gerbera and chrysanthemum, had shown an improvement of flower quality and also a larger size of the bulbs utilizing new organic composts or adding zeolites to the traditional substrates. In this trial, zeolites (Clinoptilolite, Cabasite and Litonita), as inorganic compounds, and Biomax (a compost obtained by barley crop residues), as an organic substrate, were evaluated for reducing the use of peat and for improving the size of bulbs, bulblets and bulbils and the quality of inflorescences in Asiatic Lily. The results showed that the use of zeolites and Biomax determined a significant increase of stem height and diameter, bud length and bulb size and weight. Furthermore, flower longevity was significantly improved in the cultivar 'Original Love'.

INTRODUCTION

Today peat is the most basic component of substrates used in the nursery production. For some crops, peat is used as it is, while in most cases it is employed in mixtures with other components. Peats are identified as those materials containing more or less decomposed plant residues, with an ash content below 10%. It is worldwide collected from natural deposits called peatlands. The deeper layers of such deposits are ten thousand years old and can be assigned to the late glacial or post-glacial period, while commonly used peatlands are almost one thousand years old (Lamanna et al., 1991). Among the various categories of peat, sphagnum peat represents the starting material more frequently utilized for the production of substrates because of its characteristics (D'Angelo et al., 1993): homogeneity, high moisture retention, good aeration, structural stability, a limited nutrient content, pH around 3.

The market of substrates for nursery production has grown in the last thirty years since mixtures of materials found on site (manure, beech leaves, pine needles) were not satisfactory for the needs of nurseries and gardeners (Accati Garibaldi and De Ambrogio, 1992). In Italy, where almost 200 companies manufacture and/or commercialize substrates, the annual consumption of peat is about 1 million m³ (Frangi and Tantardini, 2001). In the ornamental plants production area of Pistoia, the largest in Europe with over 5000 ha of nurseries including 1000 ha for potted plants production, the annual requirement of substrates is 35-40 thousand m³/ha, equivalent to 350-400 thousand m³/year, half of which consisting of peat as the typical substrate utilized in this region is a mixture of peat and pumice 1:1 (v/v) (www.peatsociety.fi).

There are many reasons that justify the research of alternative substrates to peat. The price increases as a consequence of the increasing costs of energy for extraction and

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transport from the producing countries of northern Europe or Canada (Rea, 2005). In addition, there is an increasing demand for “peat free” substrates as a result of the environmentalist campaign against the exploitation of peatlands because of the natural and archaeological value of these areas and of the fact that peat is not a renewable resource (Holmes and Lightfoot-Brown, 2000; Armstrong, 2004). It should be also noted that the European Commission (2001) excluded all substrates containing peat from the release of the Community Eco-Label Mark.

In many countries, such as in Holland (Armstrong, 2004) and also in our country (Project PROBIORN, of the Tuscany Region, 2004-06; Projects FLORPRO, 2007-10, and SUBARTIFLOR, 2009-12, of Mi.P.A.A.F.), several research projects have been carried out to find materials alternative to peat that combine low costs with optimal physical, chemical and biological properties. Preliminary experiments, conducted at the CRA-VIV Pescia (Italy) on Asiatic and Oriental lilies (Prisa et al., 2008), liatris and tulips (Prisa et al., 2009), gerbera daisy and chrysanthemum (Prisa and Burchi, 2010; Prisa et al., 2010) showed an improvement of flower quality and also a larger size of the bulbs utilizing inorganic compounds and a compost obtained by barley residues.

In this paper, zeolites (Clinoptilolite, Cabasite and Litonita) as inorganic compounds and Biomax (a compost obtained by barley crop residues) as organic growing medium were evaluated for reducing the use of peat and for improving the size of bulbs and the quality of inflorescences in Asiatic Lily.

MATERIALS AND METHODS

The trials were carried out at the experimental farm of CRA-VIV Pescia (43°53'52"80N, Italy). Bulblets of ‘clone 409’ (size 2/4 and 6/8) and bulbils of ‘clone 00123’ (size <2/4 and 2/4) of Asiatic Lily were planted in June 2010 in 40×60 cm² containers. About 30 bulblets and 60 bulbils were planted into each container, with 4 replicates for each treatment. The following substrates were tested: Clinoptilolite (Pure Mineral s.r.l., Pescia, Italy) 10% and Peat 90% (v/v); Biomax (A. Paladini, Gabbro, LI, Italy) 100%; Peat 100% (Control). For each substrate, treatment without fertilization or with a fertilization of 60 g of manure/container were tested. The height of the stem was evaluated at the flower ripening stage, before eliminating the flowers. The weight of the bulbs was evaluated at the end of the life cycle of the plant, when the stem was completely wilted.

Furthermore, bulbs of four cultivars of Asiatic Lily (‘Indian Diamond’, ‘Original Love’, ‘Nashville’ and ‘Brindisi’) were grown in 40×60 cm² containers (10 bulbs/container), with four replicates for each treatment. The following substrates were tested: Clinoptilolite 10% and peat 90% (v/v); Litonita (Pure Mineral s.r.l., Pescia, Italy) 5% and peat 95% (v/v); Cabasite (Pure Mineral s.r.l., Pescia, Italy) 10% and peat 90% (v/v); Biomax 100%; peat 100% (Control). For each container, 60 g of manure were added. The following qualitative parameters were evaluated on inflorescences: height and diameter of the stem (10 cm below the first flower); length of flower buds; number of flowers per stem; inflorescence longevity (number of days required for senescence of 50% of the flowers). The inflorescences were harvested by cutting the stem 20 cm below the first flower and leaving the rest of the stem to ripen attached to the bulb. At the end of the life cycle of the plant, the weight and size (circumference) of the bulbs were evaluated.

Data were subjected to analysis of variance (ANOVA) and means were compared by Student-Neumann-Keuls (SNK) test. Means showing the same letters in each column of the tables are not statistically different at $P \leq 0.05$.

RESULTS

In the trial for bulblet and bulbil enlargement, the height of the stems deriving from bulbils <2/4 cm was not measured because only leaves were produced (Table 1). The substrates with Biomax or Clinoptilolite resulted in a significant increase of the bulb size and stem height compared to their respective control (Table 1). The treatments with Biomax and Clinoptilolite without fertilization, also when compared to the fertilized

control, showed a significant increase of the bulb weight (Fig. 1) and of the stem height (Fig. 2). Furthermore, the leaf color in the plants cultivated on Biomax was darker green than in the control (Fig. 2).

In the second trial (Table 2), the results showed a significant positive effect of all tested substrates on qualitative parameters, compared to the control. No significant interactions were found for stem height and diameter, bud length, bulb size and weight. The mean stem height of all cultivars resulted between 95.2 and 99.7 cm, compared to 87.2 cm of the control. The mean bud length resulted increased from 9.1 cm in the control to 10.3-10.8 cm in the four tested substrates. The mean bulb size of all cultivars showed a significant increase from 15.0 cm in the control to 17.7-19.5 cm in the four tested substrates, and their bulb weights ranged from 39.4 to 46.8 cm, significantly higher than the control (25.2 cm) (Fig. 3). The mean stem diameter resulted significantly higher only in Clinoptilolite (1.02 cm compared to 0.78 cm in the control).

For inflorescence longevity, a positive interaction was found (Table 2), thus the data were analysed for each substrate and cultivar. The results (data not shown) showed a significant increase on flowers longevity in 'Original Love' using Clinoptilolite and Biomax (11.0 and 10.0 days, respectively) compared to the control (7.0 days).

CONCLUSIONS

The main feature of horticultural crops is the use of natural or artificial substrates to replace the soil. Currently, the most commonly utilized material is peat. The price of this material increased significantly in the last decades due to the increased energy costs affecting the entire production process, from collection, preparation and classification to transportation to the growers. Furthermore, there are other problems in the commercialization of peat due to environmental protection of peatlands.

Zeolites, commonly utilized in agriculture for the cultivation of horticultural crops such as tomato (Passaglia et al., 1997), celery (Bazzocchi et al., 1996), cucumber (Passaglia et al., 2005) and for the reduction of NH_4^+ content in the liquid manure in the pig farms (Bergero and Passaglia, 1994; Passaglia and Marchi, 2001), could resolve in part this problem. In fact these minerals, added to peat or to other organic composts at 10% content (v/v), are practical to use, easy to mix to the soil or to other substrates, also for soilless cultivation. The active nutrients and water content result always available to plants and the absorbed fertilizing elements are safe from the risk of run-off due to rain or irrigation. Also Biomax could reduce the use of peat in agriculture and improve the plants' growth by reducing soil compaction and increasing aeration.

The results of this research have shown that zeolites (Clinoptilolite, Cabasite and Litonita) and Biomax can improve some traits of plant quality in Asiatic lilies, such as stem height, bud length, flowers longevity, bulb size and weight. In particular, in the cultivation of bulblets and bulbils, treatment with Biomax and Clinoptilolite without fertilization showed a significant increase of the bulb size and stem height even if compared to the fertilized control. These data are particularly interesting considering that reduction of chemical inputs and the problem of water pollution play an important role in agriculture.

These trials showed several benefits that can be obtained through the use of these substrates: improvement of quality in Asiatic lily, better use of fertilizers and easy disposal at the end of the production cycle (the zeolites can also be reutilized), in addition to a reduced peat consumption.

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Tables

Table 1. Effect of substrates on bulblets, bulbils and stem growth.

Substrates	Bulblets - 'Clone 409'				Bulbils - 'Clone 00123'			
	Size 2/4		Size 6/8		Size <2/4		Size 2/4	
	Bulb weight (g)	Stem height (cm)	Bulb weight (g)	Stem height (cm)	Bulb weight (g)	Stem height (cm)	Bulb weight (g)	Stem height (cm)
	Not fertilized							
Control	20.55 e	22.20 c	99.34 e	31.80 d	16.88 d	-	52.86 e	20.00 d
Biomax	133.06 a	35.40 a	182.29 a	53.00 a	42.40 a	-	144.45 a	36.00 a
Clinoptilolite 10%	89.33 b	29.60 b	183.02 a	42.86 b	38.15 b	-	125.23 c	34.06 a
	Fertilized							
Control	46.68 d	23.60 c	163.49 d	37.80 c	17.48 d	-	62.77 d	24.52 c
Biomax	132.45 a	36.00 a	175.04 c	51.90 a	39.67 b	-	132.01 b	34.42 a
Clinoptilolite 10%	84.23 c	31.40 b	178.74 b	42.00 b	28.34 c	-	124.24 c	31.46 b

Table 2. Effect of substrates on qualitative parameters in Asiatic Lily.

	Stem height (cm)	Stem diameter (cm)	Bud length (cm)	Flower longevity (days)	Bulb size (cm)	Bulb weight (g)
	Cultivars					
Original Love	94.20 bc	0.91 a	9.46 b	9.27 a	16.60 c	35.55 b
Brindisi	89.93 c	1.02 a	10.58 a	9.07 ab	18.60 ab	45.50 a
Indian Diam.	101.07 a	0.90 a	10.41 a	8.53 ab	19.40 a	46.47 a
Nashville	95.53 b	0.98 a	10.33 a	8.07 b	17.40 bc	34.83 b
	Substrates					
Cabasite 10%	98.58 a	0.99 ab	10.76 a	9.17 a	17.75 a	39.35 a
Clinoptilolite 10%	99.67 a	1.02 a	10.50 a	8.83 ab	19.25 a	46.24 a
Biomax	95.25 a	1.00 ab	10.31 a	9.00 ab	18.50 a	45.41 a
Litonita 5%	95.17 a	0.97 ab	10.32 a	8.83 ab	19.50 a	46.79 a
Control	87.25 b	0.78 b	9.09 b	7.83 b	15.00 b	25.15 b
Cultivars	***	n.s.	***	*	**	***
Substrates	***	*	***	*	***	***
Interaction C×S	n.s.	n.s.	n.s.	*	n.s.	n.s.

Figures



Fig. 1. Effect of the substrate on bulbil growth in Asiatic lily (control: peat 100%).

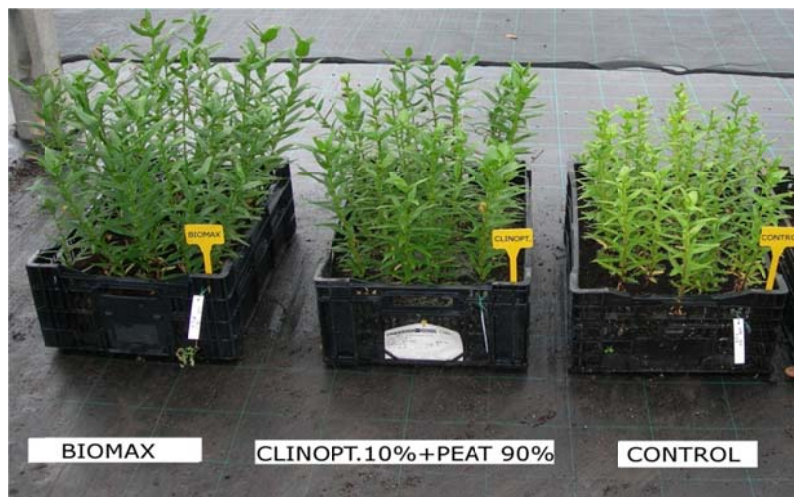


Fig. 2. Effect of the substrate on plant growth in Asiatic lily (control: peat 100%).



Fig. 3. Effect of the substrate on bulb growth in Asiatic lily (control: peat 100%).