Fertilization of *Sinningia leucotricha* (Hoehne) H.E. Moore, a species native to Paraná with ornamental and medicinal potential

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ABSTRACT

Sinningia leucotricha (known in Brazil as Queen of the Abyss) is an endangered plant species, native to the State of Parana, with the potential to be used as an ornamental and medicinal plant. This study aims to evaluate the effect of chemical and organic fertilization on its vegetative development. A completely randomized experimental design was used, with five treatments: without fertilization; Bokashi Bacsol® (1.5 g/vase); Biofert® Plus 2.5 mL.L-1; Bokashi Bacsol® (1.5 g/vase) + Biofert® Plus 2.5 mL.L-1; Bokashi Bacsol® 3 g/vase; applied once a month, with 10 replications and with each experimental unit made up of one vase containing one plant. Tuberous roots were planted in polypropylene vases containing coconut powder peel and coarse sand 1:1 (v:v). The following parameters were evaluated: number of sprouted shoots, number of leaves, length of the aerial part of the plant, length of the largest root, fresh mass of the tuberous root, diameter and length of the tuberous root and electrical conductivity and pH of the substrate. Fertilization with Bokashi 1.5 g/vase and Bokashi 1.5g/vase + Biofert® Plus 2.5mL-1 (30 mL/vase) were the two most efficient treatments for the vegetative development of *Sinningia leucotricha*.

Key words: Gesneriaceae, organic fertilizer, chemical fertilizer, vegetative development.

INTRODUCTION

The genus Sinningia has a Neotropical distribution and includes approximately 65 species, the majority being found in Brazil. Some of these, such as *Sinningia elatior* (Kunth) Chautems, have a wide geographic distribution, while the distribution of others is more restricted (Grela and Brussa 2005). One of them is the Brazilian Edelweiss (*Sinningia leucotricha*), a plant native to the state of Paraná and known for the beauty of its flowers, the shape and size of its tuberous root and its densely silvery-hairy leaf rosettes (Iuchi and Lopes 1997). It is often found in rocky, humid and shaded areas (Grela and Brussa 2005). Studies show the production of a compound named leucotricho acid from a tuberous root of this kind, which proved to be effective in the inactivation of cancerous cells in humans (Verdan et al. 2013).

Currently, this species is endangered due to habitat degradation and indiscriminate collection (Verdan et al. 2013). However, a definition of the procedures to be used for the management of this plant, such as fertilization, adequate substrate, irrigation and other factors, would promote its commercial use. In a study on the vegetative development of Brazilian Edelweiss, Unemoto et al. (2010a) recommended a mixture of coconut powder peel and sand or just sand as the substrate. According to Unemoto et al. (2010b), the level of shading also influences the vegetative development of this plant, as the highest averages of height and accumulation dry mass of the plants were registered using a shading net with a luminosity retention of 70%.

It is important to emphasize that fertilization also accelerates growth and vegetative development (Reis et al. 2011), enabling the commercial cultivation of plants (Oliveira et al. 2000). The quantity of nutrients in the substrate, the type of fertilizer and the concentration of nutrients in the solution at the moment of application are factors that must be considered. Depending on the materials used in the formulation of substrates, levels of nutrients are not always sufficient to promote satisfactory plant development and nutrient supplementation through the use of additional fertilizers is needed (Marques et al. 2003).

Some organic fertilizers work similarly to chemical or mineral fertilizers, being a source of macro and micronutrients. However, in addition to act as suppliers of nutrients, they also contribute to the level of organic matter in the soil (Malavolta et al. 2002). The use of organic fertilizers enriched with microorganisms, capable of improving conditions of microbial activity in the soil, contributes to higher levels in the soil system and in plants. Among the fertilizers available in the market, Bokashi is the most used by cultivators (Santos et al. 2007).

According to Penteado (2006) and Ishimura (2004), the Bokashi compost is a concentrated organic fertilizer, rich in nitrogen, phosphorus and potassium, and can be applied during sowing or as a top-dressing. Bokashi fermented compost is a mixture of different types of organic matter submitted to fermentation, predominantly the lactic acid fermentation process. According to Souza and Rezende (2003), the use of increasing doses of these fertilizers can directly affect the accumulation of dry mass by promoting higher availability of nutrients in the soil. The main advantage of using Bokashi is the balance it maintains between nutrients, producing an improvement in the chemical, biological and physical properties of the soil and therefore improving the organoleptic quality of the products harvested, such as vegetables and fruit, as well as reducing the incidence of disease and pests.

Studies on the effects of fertilization on the cultivation of Brazilian Edelweiss are rare. Therefore, this study aimed to evaluate the vegetative development of Brazilian Edelweiss submitted to mineral and organic fertilization.

MATERIAL AND METHODS

This study was carried out between November 2009 and May 2010 in the Department of Agronomy at the Universidade Estadual de Londrina (UEL) in the state of Paraná (latitude 23º23'S,

longitude 51º11'O and 566 m altitude), Brazil.

The experiment was carried out using tuberous roots of Brazilian Edelweiss (*Sinningia leucotricha*) Hoehne (Moore), deposited in the UEL herbarium under the registration code FUEL 48756 (Figure 1), with an average diameter of 2.82 ± 0.3 cm and average fresh mass of 7.27 ± 0.5 g.

They were planted in 12.5 cm diameter and 10.5 cm tall black polypropylene vases with four holes at the bottom, containing a layer of gravel at the bottom to optimize drainage. A 1:1 (v:v) mixture of coconut powder peel and coarse sand was used as substrate.

The vases were maintained on a bench in a greenhouse, protected with a black-colored polypropylene shading net with luminosity retention of 50%, under manual irrigation of 50 mL per vase twice a week. The maximum and minimum temperature and relative humidity of the environment registered during the experiment were 30°C, 13ºC and 76%, 62% respectively.

Five treatments were tested: T1 – without fertilization; T2 – Bokashi Bacsol® (1.5 g/vase); T3 – Biofert® Plus 2.5 ml. L-1 (30 mL/vase); T4 - Bokashi Bacsol® (1.5 g/vase) + Biofert® Plus 2.5 mL.L-1 (30 mL/vase); T5 – Bokashi Bacsol® (3 g/vase). The Biofert® Plus fertilizer contains N=8%; P=9%; K2O=9%; Mg=0.6%; S=1%; B=0.02%; Cl=1%; Co=0.005%; Cu=0.2%; Fe=0.15%; Mn=0.02%; Mo=0.005%; Zn=0.35%, and Bokashi Bacsol® fertilizer contains N=3%; P=2%; K=1.4%; Ca=2.2%; Mg=1.1%; Mn=0.018%; Zn=0.011%; Fe=0.090%; B=0.020%; Cu=0.010%; pH=6.0 and C:N=12.

A completely randomized experimental design was used with 5 treatments and 10 replications and each experimental unit was made up of one vase containing one plant. Fertilization was carried out monthly.

Six months after the start of the experiment, the following variables were evaluated: number of sprouted shoots, number of leaves, length of the aerial part of the plant (cm), length of the largest root (cm), diameter and length of the tuberous root (cm), fresh mass of the tuberous root (g), electrical conductivity (dS.m-1) and pH of the substrate.

Aerial part length (cm), the largest root length (cm) and tuberous root diameter and length (cm) evaluations were carried out using a pachymeter. Electrical conductivity was measured using a conductivity meter and the pH was measured using a digital pH meter, according to the Kämpf method (2000).

Results were submitted to analysis of variance and the averages were compared using the Tukey test at $p \leq 0.05$. The Sisvar software system version 5.3 was used for the analyses.

RESULTS AND DISCUSSION

There was no statistically significant difference in the rate of survival between the five treatments, which varied from 89 to 96% (Table 1). Fernandes et al. (2011), working with the application of organic fertilizers in Eucalyptus seedlings (*Eucalyptus urophylla*) did not report any significant influence of the use of Fert-Bokashi® on the level of the seedlings' survival. Moreover, Ototumi et al. (2001) also verified that the use of Bokashi did not influence the production of broccoli (*Brassica oleraceae* L.).

There were no statistically significant differences for the number of sprouted shoots, number of leaves and length of the aerial part of the plant, which were, on average, 1.36, 5.26 and 5.26, respectively, six months after the start of the experiment (Table 1). In a study on substrates used for the development of *Sinningia leucotricha*, Unemoto et al. (2010a) used fertilizer formulation NPK 6-6-8 and obtained an average of 1.55 sprouted shoots and 2.87 leaves per plant from a coconut powder peel and sand substrate, six months after the start of the experiment.

Treatments without fertilization showed higher averages for the length of the largest root compared to the Bokashi (3 g) treatment, with no statistically significant difference in relation to the other treatment (Table 2). However, when evaluating doses of Bokashi in the production of papaya tree (Carica papaya L.) seedlings, Hafle et al. (2009) reported that the length of the root increased linearly in relation to the dose of the Bokashi fertilizer used.

The Bokashi (1.5 g) + Biofert® Plus 2.5 mL.L-1 (30 mL) treatment showed the highest value of fresh mass for the tuberous root compared to that without fertilization and Bokashi (3 g)

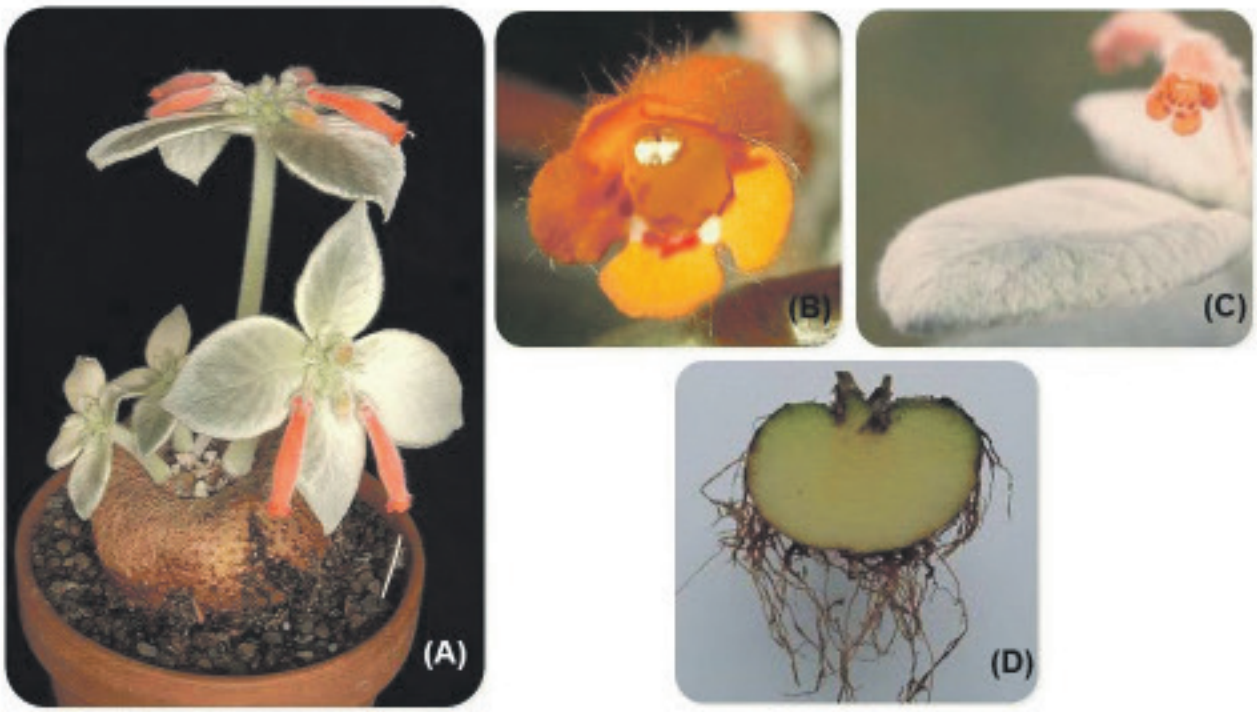

Figure 1. Aspect of cross adult plant (A), flowers (B), leaves (C) and court of tuberous root (D) of *Sinningia leucotricha* (Hoehne) Moore – Gesneriaceae.

Table 1. Survival rate (%), number of sprouted shoots, number of leaves and length of the aerial part of the plant six months after the start of the experiment involving Brazilian Edelweiss *(Sinningia leucotricha)* submitted to fertilization treatments. Londrina, PR, 2010.

Treatments	Survival (%)	No. shoots(1)	No. leaves(1)	Length of the aerial part (cm)
T1- Without fertilization	95(ns)	1.4 (ns)	6.2 (ns)	3.1 (ns)
T2- Bokashi (1.5 g)	89	1.6	5.4	3.9
T3- Biofert® Plus 2.5 mL.L^{-1} (30 mL)	96	1.3	4.9	3.8
T4- Bokashi (1.5 g) + Biofert® Plus 2.5 mL.L^{-1} (30 mL)	90	1.4	5.5	5.5
T5- Bokashi (3 g)	92	1.1	4.3	3.8
Average	92.4	1.36	5.26	4.02
CV (%)	22.23	20.2	19.0	29.3

(ns) No statistically significant difference between the treatments; (1) results submitted to a square-root transformation.

treatments (Table 2). In an experiment involving *Sinningia leucotricha* ,plants obtained from in vitro micro propagated seedlings and monthly applications of formulation NPK 6-6-8, Unemoto et al. (2010a) observed tuberous roots with fresh mass of 2.11g and fresh and dry mass of the aerial part of 0.75g and 0.35g, respectively, six months after the start of the experiment. When studying the effects of different organic fertilizers on the fresh mass of lettuce (Lactuca sativa), Trani et al. (2006) reported that a mixture of Bokashi and chicken manure showed better results compared to other treatments. Bokashi has also presented excellent results and has been recommended as an alternative to the use of chemical fertilizers in the cultivation of orchids (Takane et al. 2010).

For tuberous root diameter (cm), the Bokashi (1.5 g) treatment showed higher averages compared to that without fertilization, with no statistically significant difference in relation to the other treatment. This demonstrates the importance of fertilization in the development of the tuberous root in this species. For tuberous root length, the highest averages were obtained by the Bokashi (1.5 g/vase), Biofert® Plus 2.5 mL.L-1 (30 mL) and Bokashi (1.5 g) + Biofert® Plus 2.5 mL.L-1 (30 mL) treatments, differing statistically from the treatment without fertilization (Table 2). Unemoto et al. (2010a) obtained an average of 2.97 cm for this variable.

Table 2. Length of the largest root, fresh mass of the tuberous root, diameter of the tuberous root and length of the tuberous root six months after the start of the experiment involving Brazilian Edelweiss *(Sinningia leucotricha)* submitted to fertilization treatments. Londrina, PR, 2010.

Treatments	Length of the largest root (cm)	Fresh mass of the tuberous root (g)	Diameter of the tuberous root (cm)	Length of the tuberous root (cm)
Without fertilization	17.50 a (1)	11.19 c	3.10 b	2.30 b
Bokashi (1.5 g)	14.30 ab	30.21 ab	4.20 a	3.10 a
Biofert® Plus 2.5 mL.L^{-1} (30 mL)	14.50 ab	22.61 abc	4.00 ab	3.00 a
Bokashi (1.5 g) + Biofert® Plus 2.5 mL.L^{-1} (30 mL)	14.80 ab	38.95 a	4.10 ab	3.20 a
Bokashi (3 g)	8.80 b	22.22 bc	3.50 ab	2.60 ab
Average	13.98	25.04	3.78	2.84
CV (%)	32.2	31.2	22.2	17.9

(1) Averages followed by the same letter were not statistically different according to the Tukey test ($p \leq 0.05$).

Tuberous root characteristics are extremely important for the cultivation of Brazilian Edelweiss, as higher prices can be obtained for larger plants. According to the results obtained, the Bokashi (1.5 g) treatment can be used in isolation in the cultivation of Brazilian Edelweiss, as it did not present any significant difference in relation to the Bokashi (1.5 g) + Biofert® Plus 2.5 mL.L-1 (30 mL) treatment for any of the variables measured.

The treatment without fertilization showed the highest pH value (closest to pH neutral), differing statistically in relation to the other treatments. The Bokashi (3 g/vase) treatment and Bokashi (1.5 g/vase) + Biofert® Plus 2.5 mL.L-1 (30 mL/vase) treatment had the lowest value (Table 3). The absence of any type of fertilization in the first treatment explains the higher pH observed for the other treatments, as the substrates in these treatments became slightly acidified due to the addition of the fertilizers used in the experiment.

The Bokashi (3 g/vase) treatment differed from the others as it presented the highest electrical conductivity (Table 3). In a study on the effects of saline concentration on the micropropagation of the African violet (*Saintpaulia ionantha* Wendl), Terceiro Neto et al. (2004) verified that this is possibly one of the species sensitive to salinity. Huett (1994) commented that the absorption of water and nutrients is directly influenced by electrical conductivity. According to Bezerra (2003), different species of plant respond differently to levels of salt in the culture medium, and high levels of soluble salts may negatively effect their development. According to this study, plants should be maintained in acceptable levels of salt, at around 1.0 dS/m. Variations in the electrical conductivity of the nutritive solution may alter the physiology of the plants, leading to changes in the absorption of water and nutrients (Beltrão et al. 1997).

Table 3. Average values for conductivity and pH of the substrate six months after the start of the experiment involving Brazilian Edelweiss *(Sinningia leucotricha)* submitted to fertilization treatments. Londrina, Pr, 2010.

Treatments	pH	Electrical conductivity (dS.m^{-1})
Without fertilization	6.52 a	0.074 c(1)
Bokashi (1.5 g)	5.69 c	0.097 bc
Biofert® Plus 2.5 mL.L^{-1} (30 mL)	6.08 b	0.076 c
Bokashi (1.5 g) + Biofert® Plus 2.5 mL.L^{-1} (30 mL)	5.46 d	0.107 b
Bokashi (3 g)	5.52 d	0.189 a
Average	5.85	0.109
CV (%)	2.0	19.9

(1) Averages followed by the same letter were not statistically different according to the Tukey test ($p \leq 0.05$).

CONCLUSION

Fertilization with Bokashi 1.5g/vase, Biofert® Plus 2.5 mL.L-1 (30 mL) and Bokashi 1.5g/vase + Biofert® Plus 2.5mL-1 (30 mL/vase) were the most efficient for the vegetative development of Brazilian Edelweiss, and therefore fertilization with Bokashi 1.5g/vase is recommended for the cultivation of this species.

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