Ornamental potential of *Tropaeolum pentaphyllum* Lam.[1]

DANIELE KIEL PENTEADO PRESTES[2], FRANCINE LORENA CUQUEL[2], RAQUEL REJANE BONATO NEGRELLE[2]

ABSTRACT

Tropaeolum pentaphyllum Lam. (Tropaeolaceae) is an herbaceous, geophyte and climbing native species of the Atlantic Forest in the South east region of Brazil, known popularly as crem. In some places, the crem tubercles are appreciated in the traditional cuisine by adding strong flavor. In addition also pointed in the literature as potentially ornamental. Aiming to subsidize the validation of crem as ornamental resource, the results of the evaluation of its ornamental characteristics (morphology, growth and development) are presented as well as the result of the analysis of its acceptance as ornamental resource by floriculture traders and consumers. The ornamental potential of this species was validated by its morphological characteristics as well as by its acceptance by traders and consumers.

Keywords: crem, climber, floriculture, landscaping, Tropaeolaceae, conservation.

RESUMO

Potencial ornamental de *Tropaeolum pentaphyllum* Lam.

Tropaeolum pentaphyllum Lam. (Tropaeolaceae) conhecida popularmente como crem é uma planta herbácea, geófita, trepadeira volúvel nativa do sul do Brasil. Em alguns locais onde ocorrem, os tubérculos do crem são apreciados na culinária regional como condimento ardido. Além disso, é apontada na literatura como potencialmente ornamental. Visando subsidiar a validação de crem como recurso ornamental, apresenta-se resultado de pesquisa que avaliou o crescimento e desenvolvimento dessa espécie, quantificou seu potencial ornamental com base em características agromorfológicas e analisou a aceitabilidade desta espécie junto a comerciantes e potenciais consumidores do mercado floricultor. O potencial ornamental foi validado tanto pelas características morfológicas quanto pela aceitação de comerciantes e consumidores de flores.

Palavras-chave: crem, trepadeira, floricultura, paisagismo, Tropaeolaceae, conservação.

1. INTRODUÇÃO

Tropaeolum pentaphyllum Lam. is regionally and popularly known as "batata-crem", "crem trepador" or "crem-de-baraço". Inserted in Tropaeolaceae, it is a herbaceous, geophysical, creeping plant native from the Atlantic Forest of South and Southeast Brazil, Occurring especially in the states of Rio Grande do Sul, Paraná and Santa Catarina. It is considered selective hygrophyte and heliophila, typical of poultry edges and open areas (KINUPP, 2011).

Crem tubers are appreciated in cooking, in the places where it occurs naturally, being based on the production of preserves, that use grated and tanned vinegar tubers that are consumed as condiments (SANTOS et al., 2013; KINUPP, 2011).

It is also reported in the literature as potentially ornamental (KINUPP et al., 2011; REIS, 2007; CROVETTO, 1981), being an option to meet the floriculture market demand for new plants (WEISS, 2002). Moreover, this species is considered as interesting in the productive landscaping context, since it is attractive for fauna and for being a source of food, especially for hummingbirds and small insects (KINUPP, 2011).

Cultivation of native plants in gardens can cooperate for the conservation of national biodiversity, promote conservation *in situ* of plants threatened by the expansion of urban areas over areas of spontaneous vegetation; and promote the local fauna maintenance (OLIVEIRA, 2013; CORRADIN et al., 2011).

However, the insertion of a new ornamental plant in the market demands the adequate knowledge of its ornamental characteristics (CEIA, 2006; SPROVIERO, 2006; WEISS, 2002) as well as its acceptability by professionals working in the segment and by consumers of the product (BOUMAZA et al., 2009; STUMPF et al., 2007).

In this context, in order to subsidize the validation of crem as an ornamental resource in ecological landscaping ambit is presented a research result that evaluated the growth and development of this species and quantified its ornamental potential based on ornamental characteristics. In addition, the acceptability analysis results of this species among merchants and potential consumers is presented.

2. MATERIAL AND METHODS

Growth and development

The evaluation of *T. pentaphyllum* growth and

DO I: http://dx.doi.org/10.14295/oh.v23i2.1024

[1] Received in 28/03/2017 and accepted in 26/05/2017

[2] Universidade Federal do Paraná (UFPR), Curitiba-PR, Brasil. *Corresponding author: dkpp@uol.com.br

development was performed for two cycles of the plant. In November / 2012 were planted 51 tubers weighing between 10 and 50 grams, not sprouted, from Santa Catarina (Xaxim) and Rio Grande do Sul (Caiçara and Frederico Westphalen). One tuber was placed per a pit of 30 x 30 x 30 cm, in line with spacing of 1 m between plants in full sun location close to a 1.40 m height wire fence, which served as tutor to the plants.

Weekly monitoring of the plants was carried out, registering the occasion of the sprouting issue, number of buds and flowers produced, anthesis occasion, number of fruits and number of tubers per plant.

After natural desiccation of the aerial part, the tubers were unearthed and evaluated for the quantity and weight of newborn tubers.

Then, the tubers generated were immediately replanted, this time in vases of 33 cm of diameter, so that there was greater control on sprouting, with a wooden tutor installation of 1.90 m height. Weekly monitoring of the variables previously evaluated was performed until the end of this second growth cycle. When the plants reached the tutor's height, they were pruned in order to stimulate lateral budding.

In 2013, it was registered an minimum average temperature of 12.21 ± 3.01 ºC; maximum average temperature of 22.5 ± 2.46 ºC and total annual rainfall of 1190 mm. In 2014, it was registered an minimum average temperature of 13 ± 2.90 ºC; maximum average temperature of 23.18 ± 3,09 ºC and total annual rainfall of 1140 mm (SIMEPAR - Sistema Meteorológico do Paraná).

The average obtained in the two years of evaluation were compared, considering the completely randomized design with different number of replications, from the application of the t-test at the 5% level of probability.

Ornamental potential

Morphological characteristics of the plant as well as data obtained in the growth and development evaluation were used to makea table to evaluate the ornamental potential of temperate climber plants (Table 1). Presence of specific characteristics was punctuated with the values 0, 5 or 10, where, 0 nothing desirable and very desirable. Based on STUMPF et al., 2007, the degree of potentiality was defined from the sum of points given for each of these characteristics. Being: A) up to 50 points: low ornamental potential; B) between 51 and 100 points: average ornamental potential and C) above 100 points: high ornamental potential.

Table 1. Guide for evaluating the ornamental potential of temperate climber plants.

Characteristics	Grades		
	0	5	10
Foliage	toxic	-	non-toxic
Foliage	with thorns	-	without thorns
Foliage	-	geophyte/deciduous	perennial
Foliage	stinging	-	non- stinging
Flowers	inconspicuous	small (<5 cm)	big (≥5 cm)
Flowers	-	green	colorful
Fruit of different color from green	-	no	yes
Resistant to intense cold	no	-	yes
Growth rate	slow	average	fast
Need frequent pruning	-	yes	no
High water demand	-	yes	no
Scent	unpleasant	odorless	pleasant
Interaction with fauna	-	no	yes
Asexual propagation	hard	-	easy
Origin	-	exotic	native

Acceptability analysis with traders

For the analysis of acceptability by floriculture traders, a semi-structured interview was applied to 12 professionals who commercialized ornamental plants, representing 10% of Curitiba-PR, Brasil (TOGNON et al., 2015). In this interview, after presenting the flowering branches, photos of the plant and exchange of general information about the species, the interviewee's previous knowledge about the plant, purchase interest and sensorial analysis of the product (color, aroma, texture, size and overall appearance) were registered. Also included were questions regarding the interviewee's perception of the climbing habit of the plant, season and duration of flowering. Besides that, the importance of being a native species and also of being potentially produced by regional farmers were reported. At the end of the questionnaire, the evaluator was asked to give a grade regarding his interest in buying the product (0-5).

Acceptability analysis with consumers

The acceptability evaluation of the species by the consumers was carried out from an interview, similar to the one for the traders. Forty potential consumers were interviewed

in floriculture markets in Curitiba, through presentation of the bottled species and a brief explanation about the habit of the plant, the fact of being native and its interaction with the fauna. Of these forty respondents, 30% were men and 70% women, ranging in age from 25 to 88 years, the majority (82.5%) were between 30 and 60 years old, being all of them regular consumers of flowers and ornamental plants.

3. RESULTS

Growth and development

Growth dynamics and development of the crem tubers were similar in both cultivation cycles, with a high percentage of budding in both (95% and 100%, respectively). In the two years, the sprouts started in the second month after planting. In an asynchronous way the shoots appeared until the seventh month. From April to May, the highest rate of individuals sprouted was recorded (66%).

In the first year, when the tubers were planted in pits, shoots were sprouted far from the planting site. In addition, the intense predation of tubers by rodents was observed, resulting in only 15 intact tubers. In the second year, after 30 days of sprouting, the plants reached 1.90 m. After apical pruning, there was an average of 9.8 ± 1.3 lateral branches (Figure 1).

Figure 1. *Tropaeolum pentaphyllum* Lam: secondary branches developed after apical pruning.

In two years, the first floral buds appeared 90 days after sprouting and flowering lasted 120 days, until senescence of the aerial part, which occurred 210 days after sprouting. Thus, flowering occurred in winter, with flowers measuring at least 3.5 centimeters and at most 4 centimeters. Flowers with different stiletto sizes were registered, showing very shortened stilettos (0.1 centimeter) in relation to others of 1 centimeter (Figure 2). During September, the daily hummingbird visit was recorded in the early morning and late afternoon.

Fruiting began from the third week of September, extending until the middle of October. It was observed that shortened-styled flowers did not result in fruits.

Figure 2. *Tropaeolum pentaphyllum* Lam., Detail from: short stiletto (Vertical arrow) and long stiletto (horizontal arrow).

There was no significant difference between the cultivation cycles regarding the number of fruits and tubers, as well as the biomass production of these tubers. However, the number of flowers produced was significantly higher in the second year of cultivation (Table 2).

Table 2. Registered productivity of flowers, fruits and tubers in *Trapaeolum pentaphyllum* in two crop cycles.

Units	Average production ± standard deviation. Individual $^{-1}$	
	CYCLE I (n=7)	CYCLE II (n=15)
Flowers	66 ± 39.8 b maximum = 135 minimum = 30	126 ± 52.6 a maximum = 204 minimum = 65
Frutits	52.71 ± 41a maximum = 120 minimum = 10	40.6 ± 21a maximum = 102 minimum = 10
Tubers	2.1 ± 1.9 a maximum =6 minimum =1	1.7 ± 0.82 a maximum =3 minimum =0
Tubers Biomass (g)	70.4 ± 74.9 a maximum =200 minimum =10	58.6 ± 57 a maximum =200 minimum =8

Ornamental potential

According to Table 1 generated in this work to evaluate the ornamental potential of temperate climber plants, *T. pentaphyllum* registered a total of 135 points, indicating high ornamental potential. With the following characteristics: non-toxic, thornless, geophytic, non-weedy plant, resistant to cold, fast growing speed, no pruning necessary, no high water demand, odorless, interaction with the fauna, easy asexual propagation and of native origin, with colored flowers measuring less than 5 centimeters and fruits with different green color.

Acceptability of traders

All flower shop traders interviewed (n = 12) declared not knowing the species presented to them and were unanimous in expressing an interest in having this product for sale and for use in their landscape projects. Most of them justified their appreciation for the species because it was new to the market (92%) as well as for blossoming in winter, being cold tolerant and attracting hummingbirds (95%). The fact of being native was also appreciated by 83% of traders and 17% emphasized how interesting the herbaceous characteristic of the evaluated vine. Only 2% justified their species appreciation only because it attracted hummingbirds.

Consumers acceptability

Although unknown to most consumers interviewed (97.5%), most of these (87.5%) Evidenced interest in purchasing *T. pentaphyllum* as an ornamental climbing plant. Of these, 67.5% stated that they would prefer to purchase this species because it is native and / or produced by regional farmers.

In the sensorial analysis of the product, the majority of interviewees were satisfied with the color, texture, size and general appearance of the plant (Table 3). The average of the grade relative to purchase interest of the product was 4.53 $\pm$ 0.99 and mode equals 5.

Table 3. Sensorial analysis results of *Tropaeolum pentalhyllum* as a climbing ornamental species to potential consumers (n = 40).

Criteria	Pleasant	Indifferent	Unpleasant
Color	95%	5%	0%
Scent	0%	100%	0%
Texture	90%	10%	0%
Size	85%	12.5%	2.5%
Overall Appearance	100%	0%	0%

In the questions regarding the perception of the interviewees regarding the general aspects of the plant, it was observed a high acceptability by potential consumers (Table 4).

Table 4. *Tropaeolum pentalhyllum* results of general aspects evaluation as a climbing ornamental species to potential consumers (n = 40).

Criteria	Pleasant	Indifferent	Unpleasant
Climber	95%	5%	0%
Flowering time	95%	2.5%	2.5%
Duration of flowering	95%	5%	0%
Attracts hummingbirds	100%	0%	0%
Annual Cycle	50%	40%	10%

4. DISCUSSION

The potential use of *T. pentaphyllum* as an ornamental plant was validated both for its morphological characteristics and for its acceptability to consumers. Most commercially grown ornamental climbing plants bloom only in the spring and/or summer, not tolerating intense low temperatures. Among those that bloom in colder times, the "Cipó de São João" (*Pyrostegia venusta* (Ker Gawl.), and Wisteria (*Wisteria sinensis* (Sims) A.P. from Cand.). Both are woody and bulky plants, unsuitable for smaller areas (LORENZI, 2008). In addition, are also available in the market: Hera (*Hedera helix* L.) and "Unha-de-gato" (*Ficus pumila* L.), both of inconspicuous flowers (PETRY, 2003).

Among the species of vines commercialized, some also have usege limitation because they are toxic plants (*Allamanda catartica* L) (AKAH ,1992) or present other undesirable characteristics, such as thorns (*Bougainvillea spectabilis*) (LORENZI, 2001). Therefore, in this scenario, *T. pentaphyllum* stands out for presenting a very attractive set of characteristics and, being one more option next to the already commercialized species. Also, because it is a native creeper, very resistant to cold, including frost. Its flowers and fruit appear during the winter. It is non-toxic and has no thorns (FLORA IBÉRICA, 2011).

It was also observed during the experiment that its form of fixation through the twisting of its petioles dispenses the need for constant conduction, and yet its volatile herbaceous nature is desirable when the plant is conducted close to constructions, since it attaches without deterioration of painting or structures of the building. It can even be used in places that would not support the weight or volume of semi-herbaceous or woody climbing plants, for example in apartment balconies.

It is a geophyte species, but its growth is fast, 12 cm day^{-1} in the juvenile stage of the plant, since the density of the green area is small, given its liana habit (ENGEL et al., 1998). In this way the apical pruning, which stimulates the lateral shoots, was presented as a good solution to give more volume to the plant and to be more suitable for ornamentation.

Additionally, for being a native species, it is highly adapted to the edaphoclimatic conditions of its natural occurrence region (OLIVEIRA et al., 2013). It is suitable for composing associations with other native species in landscaping, simulating natural conditions and appearing spontaneity (TABACOW, 2004), also favoring the maintenance of the pollinating and dispersing fauna, like hummingbirds that are attracted by its flowers with nectariferous spurs (FABBRI, 1998). In this perspective, it meets a current demand to combine landscaping with nature conservation in an ecological landscaping context (HOUGH, 1995). Another favorable feature of this species is the fact that its flowers are edible (KINUPP et al., 2011). Therefore, they may be used in the ornamentation and composition of culinary recipes, this way, serving one more market niche, the gastronomical. In addition, its insertion in the floriculture market, associated to the production in commercial scale would still help in the preservation of this plant. Since the destruction of its natural occurrence environment for the formation of pastures and agricultural areas, as well as the extractivism pressure of its tubers, has placed this species at the level of extinction vulnerability (KINUPP et al., 2011).

However, studies regarding the biological aspects are needed, as we observed that the relation between stiletto size and fruit generation deserves to be further investigated. Since some flowers presented an almost imperceptible stilettos and these did not produce seeds, whereas the longistila flowers produced seeds. Also agronomic studies that aim to generate subsidies for their insertion in the cultivation system are essential in this context.

The asynchronous budding can provide several growing seasons, but the appearance and behavior of stoloniferous bud, arising far from the mother tuber, still pose problems that need to be further evaluated, as also pointed out by KINUPP (2011). However, it was evidenced that the potted planting may be an option for better control of the budding site and protection against attacks of rodents.

It should be noted that potting did not affect the production of flowers, fruits or tubers. The plants cultivated in vases showed more flowers compared to those grown in the soil. This is explained by the increase in plant density, since in the vase the plants were tufted and pruned at their apex, which generated the appearance of more lateral branches that also produced flowers. However, further research is still needed to determine what would be the best commercial presentation, whether in the form of tubers or the already bottled plant.

CONCLUSIONS

Tropaeolum pentaphyllum is indicated as an ornamental plant, especially in temperate climate conditions, both for its morphological characteristics and its acceptability to consumers. It is a species that presents many ornamental possibilities. Because it is an herbaceous vine, it can be cultivated in soil or in vases; tiled in fences, trusses, railings or screens; in large or small areas. It does not offer risks or inconveniences; on the contrary, its interaction with the fauna provides great pleasure to those who live with the plant. However, the obtained results analysis comparatively to those reported in the literature indicates a great heterogeneity regarding the sprouting season. Therefore, specific assessments are required regarding genetic variability and agronomic techniques for the conservation of this species and protocols formation for commercial cultivation. *Tropaeolum pentaphyllum* is still not produced on a commercial scale, and the few who grow it in their yards for their own use sell only surplus production to small businesses in the local region. In these cases, they use vegetative propagation as a cultivation method, through the budding of the tubers. Studies related to sexual propagation and germplasm bank formation are necessary to ensure the different floral characteristics conservation of color and form still available in nature.

AUTHORS CONTRIBUTIONS

D.K.P.P.: performed the research, collected the information, performed the interviews, analyzed the data, take the photos, made the figures and wrote the first draft of the manuscript. **R.R.B.N.**: helped in development of the idea of the research and in adapting the methodology, performed part of the research, take the photos, as well as critical reading and editing of the manuscript. **F.L.C.**: helped in development of the idea of the research and in adapting the methodology as well as critical reading of the manuscript.

REFERENCES

AKAH, P.A.; OFFIAH, V.N. Gastrointestinal effects of *Allamanda cathartica* leaf extracts. **International Journal of the Pharmacognosy**, v.30, n.3, p.213-217, 1992.

BOUMAZA, R.; DEMOTES-MAINARD, S.; HUCHE-THELIER, L.; GUERIN**,** V**.** Visual characterization of the esthetic quality of the rosebush**. Journal of Sensory Studies**, v.24, p.774-796, 2009.

CORRADIN, L.; SIMINESKI, A.; REIS, A. **Espécies nativas da flora Brasileira de valor econômico atual ou potencial: Plantas para o Futuro - Região Sul.** Brasília: Ministério do Meio Ambiente, 2011, 934p.

CROVETTO, M. **Guía de Consultas Botánica II**. Facultad de Ciencias Exactas y Naturales y Agrimensura (UNNE) ROSIDAE-Geraniales-Tropeolaceae, 1981. Disponível em:< http://www.biologia.edu.ar/diversidadv/fascIII/40.%20Tropeolaceae.pdf> Acesso em: 10 de junho de 2011.

ENGEL, V. L.; FONSECA, R. C. B.; OLIVEIRA, R. E. Ecologia de lianas e o manejo de fragmentos florestais. **Série Técnica. IPEF.** v.12, n.32, p.43-64, 1998.

FABBRI, L. T.; JUAN, J. V. Aspectos de La Biología Reproductiva de *Tropaeolum pentaphyllum* (Tropaeolaceae). **Darwiniana.** Disponível em:< https://www.researchgate.net/profile/Liliana_Fabbri/publication/292558056_Some_aspects_of_the_reproductive_biology_of_Tropaeolum_pentaphyllum_Tropaeolaceae/links/5703f53108aef745f7148999.pdf>. Acesso em 22 de abril de 2013.

Flora Ibérica. Rosaceae. Disponível em:<http://www.floraiberica.es/floraiberica/texto/pdfs/06_087_13%20Rosa.pdf>. Acesso em 10 de junho de 2014.

Flora Ibérica. Tropaeolum. Disponível em: <http://www.floraiberica.es/floraiberica/texto/imprenta/tomoIX/09_125_Tropaeolaceae_2011_05_19.pdf>. Acesso em 10 de junho de 2014.

HOUGH, M. **Naturaleza e Ciudad, Planificacion Urbana y Processos Ecológicos**. México: Editorial Gustavo Gili, 995.

KINUPP, V.F.; LISBÔA, G.N.; BARROS, I.B.I. **Espécies Nativas da Flora Brasileira de Valor Econômico Atual ou Potencial-Plantas para o Futuro - Região Sul**, Brasilia: MMA, cap.5, 2011, 243p.

LORENZI, H. **Plantas ornamentais no Brasil:** arbustivas, herbáceas e trepadeiras. Nova Odessa: Instituto Plantarum, 2001. 1088p.

LORENZI, H. **Plantas ornamentais no Brasil:** arbustivas, herbáceas e trepadeiras. Nova Odessa: Instituto Plantarum, 2008. 1088p.

OLIVEIRA J.C.J.F.; GONÇALVES, F.S.; COUTO, F.; MATAJS, L. Potencial das espécies nativas na produção de plantas ornamentais e paisagismo agroecológico**. Revista Brasileira de Agroecologia**, v.8, n.3, p.190-200, 2013.

PETRY, C. **Estilos de Jardins**. In: Apostila da disciplina de Paisagismo, Parques & Jardins. Passo Fundo: UPF, 2003.

REIS, A.; SIMINSKI, A. **Plantas do Futuro - Região Sul**. Brasília: Ministério do Meio Ambiente, 2007. 936p.

SANTOS, T.C.; BOFF, P.; BOFF, M.I.C.; VOLPATO, C. Ocorrência e multiplicação do crem (*Tropaeolum pentaphyllum* Lam.) na Serra Gaúcha e Planalto Sul Catarinense. **Cadernos de Ecologia**, v.8, n.3, 2013.

SPROVIERO, M. B. **Os transcedentais e sua negação: O belo e o bom / O mal e o feio**. Disponível em: < http://www.hottopos.com/collatio/os_transcendentais_e_sua_negacao.htm >. Acesso em: 20 de janeiro de 2015.

STUMPF, E.T.; HEIDEN, G; ROSA, L. B.; FISCHER, S.L; RAQUEL, R. S.; ZANCHET, B.; GROLLI, P.R. Método para avaliação da potencialidade ornamental de flores e folhagens de corte nativas e não convencionais. **Revista Brasileira de Horticultura Ornamental**, v.13, n.2, p. 143-148, 2007.

TABACOW, J. **Roberto Burle Marx - Arte e paisagismo**. 2 ed. São Paulo: Studio Nobel, 2004.

TOGNON, G.B.; AMARAL, W.; BOLZAN,R.P.; CUQUEL, F.L. Ornamental Potential and Postharvest of *Baccharis uninella* D.C. **Acta Horticulturae**, v.1000, 2015

WEISS, D. Introduction of new cut flowers; domestication of new species and introduction of new traits not found in commercial varieties. In: VAINSTEIN, A. (Ed.) **Breeding for ornamentals**. Dordrecht: Springer, 2002. p.47-83.