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Evaluation of the Winter-hardy Yucca taxa among extreme conditions in landscape applications

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Abstract: The *Agavaceae* are mostly adapted to arid conditions; the majority are xeromorphic and succulent rosette plants of desertic regions. In Hungary, the limiting factor of application of *Yucca* taxa is not the hot summer but the humid and cold weather in winter. Despite of the fact that more than the half of the 59 recognised taxa is winter-hardy, in the practice of the planting design and horticulture in Hungary the number of the applied taxa is only 3 or 4. Our evaluation is based on the observing of bedded-out plants to rock gardens in four locations: one garden is in the Zoological and Botanical Garden of Budapest, two places are in private collections (Érd, Budakeszi) and the last one is in the Botanical Garden of ELTE. In all of these collections there were planted selected species that – according to the references – survive the temperature -10 °C.

Keywords: winter-hardy, frost resistant, *Yucca* species, Hungarian collection

1. Introduction

Earlier the yuccas (vernacular name is Palm Lily) have belong to a separate family. Then in classifications the *Agavaceae* with 2 tribes were recognized as separate members, emphasizing the ovary position in broadly circumscribed tribe *Agaveae* with inferior ovary and tribe *Yucceae* with superior ovary [1]. The Angiosperm Phylogeny Group's 2009 classification places Agavaceae, along with a number of other families (including *Ruscaceae*) in an expanded family of *Asparagaceae*.

The traditional infrageneric division of *Yucca* [2, 3] is as follows:

Sections:

- *Chaenocarpa* Engelm
- *Clistocarpa* Engelm
- *Yucca* (formerly *Sarcocarpa*) Engelm and
- the section *Hesperoyucca* Engelm is separated currently

Yucca is a genus of woody perennial shrubs and trees in the family. It is a terrestrial plant (very rarely epiphitic: *Y. lacandonica*), stems none, short or thick and arborescent, then usually more or less branched. Its species are notable for their rosettes of evergreen, with numerous sword-shaped leaves which are more or less ensiform. These leaves are nearly linear, thin or flexible maybe somewhat thicker and very rigid having horny or smooth margins, which are often desintegrate into fibres and terminal spines often present.

Characteristically there are large terminal panicles of white or whitish flowers. Ovary is superior, 3-locular [4]. Fruits are many seeded loculicidal capsules with intruding dorsal false septa, more rarely septicidal or baccate and indehiscent.

They exhibit a high water-use efficiency connected with the common occurrence of the water-conserving Crassulacean Acid Metabolism like CAM-mode of photosynthesis (present in all species of *Agave* so far studied and in some *Yucca* and *Hesperaloe*) [5].

They are native to the hot and dry (arid) parts of North America, Central America, South America, and the Caribbean. To the south, the genus is represented throughout Mexico and extends into Guatemala. *Yucca* plants have adapted to an equally vast range of climatic and ecological conditions. They are to be found in rocky deserts and badlands, in prairies and grassland, in mountainous regions, in light woodland, in coastal sands.

2. Materials and Methods

Yuccas are widely grown as ornamental plants in gardens [6]. In Hungary, the limiting factor of application of *Yucca* taxa is not the hot summer but the humid and cold weather in winter.

Our evaluation is based on the observing of bedded-out plants to rock gardens in four locations: one garden is in the Zoological and Botanical Garden of Budapest, two places are in private collections (Érd, Budakeszi) and the last one is in the Botanical Garden of ELTE. In all of these collections there were planted selected species that – according to the references – survive the temperature -10 °C.

The genus *Yucca* is “one of the most difficult” of USA [7] due to its complex nomenclature including many older names of uncertain application and horticultural names, as well as the variability of many taxa, which apperently often includes hybridization and introgression. According to the publication of THIEDE [8] can be

expected that the adaptation of these plants would be increase. The number of recognised taxa are 62 but the number of the current/vulgar names are 316.

3. Results and discussions

According to the references among the recognised taxa there are more than 40 frost resistant species and several assortments. Noticeable in *Table 1.* there are 34 taxa that tolerate colder weather than -18 °C there are 7 ones in all the four gardens like *Y. arkansana, Y. flaccida, Y. filamentosa, Y. glauca* var. *glauca*, *Y. glauca* var. *stricta*, *Y. gloriosa* (*Figure 1.*), *Y. recurvifolia* and each of further 6 taxa can be found in three collections like *Y. angustissima* var. *angustissima, Y. baccata* var. *baccata, Y. baileyi* var. *baileyi*, Y. *constricta,* Y. *elata* var. *elata, Y. harrimaniae* var. *neomexicana*.

Figure 1: *Yucca gloriosa* in the collection of Érd in 2006.

*Table 1***.** Winter-hardy *Yucca* taxa (A group) in four collection*.

	TAXA	AUCTOR	WH	Zoo	Érd	Buda-keszi	ELTE	Σ
1	*Yucca angustissima* var. *angustissima*	Engelmann ex Trelease (1902)	A		1	1	1	**3**
2	*Yucca angustissima* var. *avia*	Reveal (1977)	A			1		**1**
3	*Yucca angustissima* var. *kanabensis*	(McKelvey) Reveal (1977)	A		1	1		**2**
4	*Yucca angustissima* var. *toftiae*	(Welsh) Reveal (1977)	A			1		**1**
5	*Yucca arkansana*	Trelease (1902)	A	1	1	1	1	**4**
6	*Yucca baccata* var. *baccata*	Torrey (1859)	A	1	1	1	ø	**3**
7	*Yucca baccata* var. *vespertina*	McKelvey (1938)	A	1			ø	**1**
8	*Yucca baileyi* var. *baileyi*	Wooton & Standley (1913)	A		1	1	1	**3**
9	*Yucca baileyi* var. *intermedia*	(McKelvey) Reveal (1977)	A	1	1	ø		**2**
10	*Yucca baileyi* var. *navajoa*	(Webber) Webber (1953)	A			ø		**0**
11	*Yucca constricta*	Buckley (1863)	A	1	1	1		**3**
12	*Yucca elata* var. *elata*	Engelmann (1882)	A		1	1	1	**3**
13	*Yucca elata* var. *utahensis*	(McKelvey) Reveal (1977)	A					**0**
14	*Yucca elata* var. *verdiensis*	(McKelvey) Reveal (1977)	A					**0**
15	*Yucca faxoniana*	(Trelease) Sargent (1905)	A	1				**1**
16	*Yucca filamentosa*	Linné (1753)	A	1	1	1	1	**4**
17	*Yucca flaccida*	Haworth (1819)	A	1	1	1	1	**4**
18	*Yucca flaccida* var *smalliana*	(Fernald) D. B. Ward (2004)	A					**0**
19	*Yucca glauca* var. *glauca*	Nuttall (1813)	A	1	1	1	1	**4**
20	*Yucca glauca* var. *stricta*	(Sims) Trelease (1902)	A	1	1	1	1	**4**
21	*Yucca gloriosa*	Linné (1753)	A	1	1	1	1	**4**
22	*Yucca harrimaniae* var. *harrimaniae*	Trelease (1902)	A		1	1		**2**
23	*Yucca harrimaniae* var. *neomexicana*	(Wooton & Standley) Reveal (1977)	A		1	1	1	**3**
24	*Yucca harrimaniae* var. *sterilis*	Neese & Welsh (1985)	A			ø		**0**
25	*Yucca linearifolia*	Clary (1995)	A	1				**1**
26	*Yucca louisianensis*	Trelease (1902)	A			1		**1**
27	*Yucca pallida*	McKelvey (1947)	A			1		**1**
28	*Yucca recurvifolia*	Salisbury (1806)	A	1	1	1	1	**4**
29	*Yucca rostrata*	Engelmann ex Trelease (1902)	A	1	P	1		**2**
30	*Yucca rupicola*	Scheele (1850)	A			1		**1**
31	*Yucca schottii*	Engelmann (1873)	A	1	P			**1**
32	*Yucca thompsoniana*	Trelease (1911)	A	1	P			**1**
33	*Yucca torreyi*	Shafer (1908)	A	1	P	1		**2**
34	*Yucca treculiana*	Carriére (1858)	A	1	P			**1**

**In the table there are different characters like "WH" as winter-hardiness "P" as protected or "0" with cancellation which refers the ruined species in that collection. The categories are in evidence in the column of winter hardiness. In the last column of the table the summation can be seen, the appearances of the taxa in the collections.*

The table is enough extensive so you can see a little part of the entire. The recognised taxa were divided 3 parts, 3 categories of winter-hardiness:

A group - which tolerate colder weather than -18 °C in Hungarian climate condition,

B group - which tolerate colder weather than -12 °C with some protection (*Table 2.*),

C group - which tolerate below zero with a few degrees, but in winter period they need unheated greenhouse.

Some of the observed species could not be adapted to the humid cold weather; the unfavourable effect of the winter 2008/2009 appeared only to six species (*Yucca brevifolia* var. *jaegeriana*, *Y. schidigera*, *Y. aloifolia*, *Y. carnerosana* (*Figure 2*), *Y. filifera*, *Y. rigida*) in the rock garden of the ZOO.

*Table 2***.** Winter-hardy *Yucca* taxa (B group) in four collection*.

	TAXA	AUCTOR	WH	Zoo	Érd	Buda-keszi	ELTE	Σ
35	*Yucca brevifolia* var. *brevifolia*	Engelmann (1871)	B?					**0**
36	*Yucca queretaroensis*	Pina Lujan (1989)	B?					**0**
37	*Yucca valida*	Brandegee (1889)	B?					**0**
38	*Yucca brevifolia* var. *jaegeriana*	McKelvey (1935)	B		1	**Ø**		**1**
39	*Yucca schidigera*	Roezl ex Ortgies (1871)	B		1			**1**
40	*Yucca aloifolia*	Linné (1753)	B	1	1	1	1 (A)	**3**
41	*Yucca carnerosana*	(Trelease) McKelvey (1938)	B	1	1			**2**
42	*Yucca filifera*	Chabaud (1876)	B	1	1			**2**
43	*Yucca rigida*	(Engelmann) Trelease (1902)	B	1	1			**2**
44	*Yucca cernua*	Keith (2003)	?					
43	*Yucca rigida*	(Engelmann) Trelease (1902)	B	1	1			
44	*Yucca cernua*	Keith (2003)	?					
45	*Yucca jaegeriana*	(McKelvey) L. W. Lenz (2007)	?					

**The appellations are the same as Table 1.*

In the last two lines, *Yucca cernua* and *Y. jaegeriana* species' data of winter-hardiness has not known in the references yet only thinkable these species belongs to B group. These newfound species are not yet in any Hungarian collections. In the line of *Y. aloifolia* we can see "A" in brakets which refers that in that collection there are so clones which alive in outdoor and survive Hungarian climate condition

without any protection. These plants are single occurrence, their propagation is marginal so primarily they need for familiarize among the collectors.

Figure 2: The rigid, bluish green leaves with margins richly filiferous of *Yucca carnerosana* in the ZOO (2008).

Figure 3: Numerous linear green and persistent when old leaves of *Yucca linearifolia* in the ZOO (2008)

According to the references there are 45 frost resistant or from these taxa there are 34 winter-hardy species. It follows aside from species of B group in Hungarian climate condition the winter-hardy species can be competent in bedding out of rock garden, perennial bed, splay or sector beetwen two lane in multi-lane street. All the same in the practice of the planting design and horticulture the number of the applied taxa are only 3 or 4. The common species (*Y. filamentosa, Y. gloriosa, Y. recurvifolia*) are hardy outdoors in Central Europe and therefore widely cultivated in many selections, includig variegated forms, are advantageous for several aspects like propagation, price and availability. In the *Table 3.* put in context can be evidence comparison of common and uncommon species.

Table 3. Comparison of the taxa of *Yucca*

Aspects	Common species	Uncommon species
Habit	Not very spectacular	Extraordinary beauty
Necessities of life	Easy cultivation	Easy to keep, but needs good drainage
Propagation	Generative - mutualistic pollination system - manual pollination (artificial insemination) Vegetative - easy	Generative - mutualistic pollination system - manual pollination (artificial insemination) Vegetative - difficult
Applications	rock garden, perennial bed	rock garden, perennial bed, solitaire
Price	cheap	expensive
Availability	available	in short supply

Characterization of some uncommon species

Despite of preceding some poorly known species are the next:

Y. rigida, which has linear leaves slightly broadened in the middle, slightly canaliculate, thin, yellowish-green and glaucous, The tip of its is very pungent. *Y. rigida* belogs to group B.

Y. thompsoniana earlier was a subspecies of *Y. rostrata*. The plants are arborescent, stems, erect with comparatively long ascending or diffusive. The rosette frequently asymmetrical, rather small, leaves few, linear or somewhat broader towards the middle, flat or canaliculate, the margins are horny yellow or brownish colour.

Y. linearifolia (*Figure 3.*) has mostly single stem, its rosette is with somewhat flattened top. There are linear leaves, which are distally twisting slightly outwards, persistent when old, reflexing and completely covering the trunk, margins thin, horny, pale yellow, minutely denticulate, terminal spine is dark, reddish brown to black

Y. baccata var. *baccata* is acaulescent plant or rarely short stems, its observable assimetrical and rather open, mostly simple or clumped rosette, leaves are more erect, straight but *Y. baccata* var. *vespertina* has falcate, rather narrow, blue-green, glaucous leaves with fibres fine, wiry. Inflorescence shorter to just slightly longer than the leaves.

Y. carnerosana stems generally simple sometimes forming groups of stems united at the base, leaves are more than 50 cm come to that 1 m, rigid, margins richly filiferous.

Y treculiana (*Figure 4, 5*.) is in a stem forming group of variable hight. It has rigid and concave leaves with yellowish green margin.

Figure 4: Simple stem of *Yucca treculiana* with low dry leaves owing to the frost in the ZOO (2011)

Figure 5: The teardrop flowers of *Yucca treculiana* in the ZOO (2011)

Y. elata var. *elata* grows come to that 4 m tall, large rosette with numerous, divergent, finally reflexing and persisting as a dry skirt on the trunk.

Many species of yucca also bear edible parts, including fruits, seeds, flowers, flowering stems, and more rarely roots. References to yucca root as food often stem from confusion with the similarly spelled but botanically unrelated yuca, also called cassava (*Manihot esculenta*). Roots of soaptree yucca (*Yucca elata*) are high in saponins and are used as a shampoo in Native American rituals [9]. Dried yucca leaves and trunk fibers have a low ignition temperature, making the plant desirable for use in starting fires via friction [10].

Yuccas have a very specialized, mutualistic pollination system, being pollinated by yucca moths (Pronuba yuccasella, family Prodoxidae); the insect purposefully transfers the pollen from the stamens of one plant to the stigma of another, and at the same time lays an egg in the flower; the moth larva then feeds on some of the developing seeds, always leaving enough seed to perpetuate the species [11]. In

Hungary there are not such a little month therefore on behalf of mature fruit with viable seeds need to pollinate manual.

Y. harrimaniae var. *neomexicana* acaulescent, forming dense to open clumps rosette. Their leaves linear narower than var. *harrimaniae,* only 7-20 mm broad.

4. Conclusion

The number of recognised taxa are 62 but the number of the current/vulgar names are 316. According to the references there are 45 frost resistant or from these taxa there are 34 winter-hardy species. In Hungary, the limiting factor of application of *Yucca* taxa is not the hot summer but the humid and cold weather in winter. Accordingly environmental circumstances can be suitable for the plants such as good drainage, sunlit places without irrigation. Species of A and B group in Hungarian climate condition can plant out but species of B group need cover for protection of precipitation in winter period.

The winter-hardy taxa which can be kept outside even during the wintertime have an increasing role in the broadening of the Hungarian ornamental plant market. They can be successfully used in rock-gardens, perennial beds and as solitaire plants at special public domains.

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References

[1] DAHLGREN et al (1985): The families of the *Monocotyledons:* Structure, evolution and taxonomy. Springer-Verlag, Berlin.

[2] MCKELVEY, S. D. (1938): Yuccas of the southwestern United States Part I. The Arnold Arboretum of Harvard University. Jamaica Plains

[3] MCKELVEY, S. D. (1947): Yuccas of the southwestern United States Part II. The Arnold Arboretum of Harvard University. Jamaica Plains

[4] PODANI, J. (2003): A szárazföldi növények evolúciója és rendszertana, ELTE Eötvös Kiadó, Budapest. p. 131-132.

[5] NOBEL, P.S. (1988): Environmental biology of Agaves and Cacti. Cambrige University Press, New York, pp 106-109
[6] GENTRY, H. S. (1982): Agaves of Continental North America. University of Arizona Press. Tucson, Arizona
[7] REVEAL, J. L. (1977): *Agavaceae.* in CRONQUIST, A.: Intermontain Flora, vol. 6. New York
[8] THiede, J (2001): Agave. in EGGLI, U. (ed): Illustrated Handbook of Succulent Plants: Monocotyledons Sukkulenten-Sammlung Zurich Switzerland
[9] WALL, M. E. és FENSKE, C. (1961): Steriodal sapogenins. LXI. Steroidal sapogenins content of seeds. Economic Botany XV:131-132. Publ. Soc. New York Bot. Garden
[10] OLDFIELD, S. comp. (1987): Cactus and Succulent Plants Status Survay and Conservation Action Plan. IUCN/SSC Cactus and Succulent Specialist Group. IUCN, Glant, Switzerland and Cambridge.
[11] POWEL, J. A. (1984): Biological interrelationship of month and *Yucca schottii.* Univ. Calif. Publ. Entomol. 100: 1-93.