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Aegean Climate Compatible Ornamental Grass Species and Visual Properties for Landscape Design[A]

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Abstract: Landscape architecture is a multidisciplinary branch based on the principle of conservation and / or re-creation of ecological balance. Landscape design is the fusion of both living and inanimate material based on this principle. The plant material, which is absolute for ecological balance, is classified hierarchically and used in the form of trees, shrubs, climbers, groundcovers, and grass groups. Within this structure, ornamental grasses constitute a group which is relatively new and infrequently used in Turkey. Ornamental grasses - the group of plants that develop mainly in ground covering or bushy form - are ecologically prominent, due to relatively low water consumption and design prominent, due to contribution to landscape colour and motion.

In this research, 21 species and its 14 cultivars of 10 grass genera, *Acorus gramineus* 'Ogon' and 'Variegatus'; *Carex comans* 'Bronze'; *Carex morrowii* 'Ice Dance'; *Carex oshimensis* 'Everest' and 'Evergold'; *Carex testacea*; *Cortaderia selloana* 'Gold Band' and 'Silverstar'; *Leymus arenarius*; *Liriope muscari* and *L. muscari* 'Variegata'; *Miscanthus sinensis* 'Flamingo' and 'Zebrinus'; *Muhlenbergia capillaris*; *Ophiopogon japonicus* and *O. japonicus* 'Variegatus'; *Pennisetum viridescens*; *Pennisetum setaceum* 'Rubrum' and *P. villosum* with *Stipa tenuissima*, were observed over a four season period in Aegean climatic conditions; in this process, the plants' adaptation to the area together with the visual changes they demonstrated were examined.

A This study does not require ethics committee permission. Yapılan bu çalışma etik kurul izni gerektirmemektedir.

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As a result, among the grass group plants sold for the landscape sector in the Bayındır district of Izmir, the species which provided open field adaptation and avoided visual deterioration were determined. Therefore, a guiding source has been produced for compatible ornamental grass species and their visual characteristics which can be used in landscape designs in Aegean and Mediterranean climates.

In this direction, it is aimed to spread the use of these grasses in order increase biodiversity and expand the visual richness of environmentally friendly landscape designs.

Keywords: Ornamental grasses, groundcovers, landscape design, grasses, xeriscape.

Peyzaj Tasarımlarında Kullanılabilecek Ege Bölgesine Uyumlu Süs Çimi Türleri ve Görsel Özellikleri

Öz: Peyzaj mimarlığı, ekolojik dengenin korunması ve/veya yeniden oluşturulması prensibine dayalı multidisipliner bir branşdır. Peyzaj tasarımı ise gerek canlı gerekse cansız materyalin birlikteliğini, bu prensibe oturtarak kurgular. Ekolojik denge için mutlak olan bitkisel materyal, ağaç-ağaççık, çalı, sarılıcı-tırmanıcı, yer örtücü ve çim grupları şeklinde hiyerarşik olarak sınıflandırılarak kullanılmaktadır. Bu düzen içinde, Türkiye için göreceli olarak yeni ve sıklıkla kullanımına rastlanmayan bir grubu ise süs çimleri (ornamental grasses) oluşturmaktadır. Süs çimleri, nispeten düşük su tüketimleri nedeniyle ekolojik, peyzaja hareket katmaları nedeniyle de estetik olarak ön plana çıkan; genel olarak yer örtücü veya çalımsı formda gelişen bitki gruplarından oluşmaktadırlar.

Bu çalışmada, *Acorus gramineus* 'Ogon' ile 'Variegatus'; *Carex comans* 'Bronze'; *Carex morrowii* 'Ice Dance'; *Carex oshimensis* 'Everest' ile 'Evergold'; *Carex testacea*, *Cortaderia selloana* 'Gold Band' ile 'Silverstar'; *Leymus arenarius*; *Liriope muscari* ile *L. muscari* 'Variegata'; *Miscanthus sinensis* 'Flamingo' ile 'Zebrinus'; *Muhlenbergia capillaris*; *Ophiopogon japonicus* ile *O. japonicus* 'Variegatus'; *Pennisetum viridescens*; *Pennisetum setaceum* 'Rubrum' ve *P. villosum* ile *Stipa tenuissima* olmak üzere 10 grass cinsine ait 21 tür ve bunların 14 çeşidinin Ege Bölgesi koşullarında geçirdiği 4 mevsimlik dönem gözlenmiş, bu süreçte bu bitkilerin gösterdikleri alan adaptasyonu ile görsel değişimleri incelenmiştir.

Sonuç olarak, İzmir Bayındır ilçesinde, peyzaj sektörüne yönelik olarak satışı yapılan grass grubu bitkiler arasından, açık alan adaptasyonunu sağlayabilen ve görsel bütünlüğü bozulmayan türler saptanmıştır. Dolayısıyla, Ege ve Akdeniz iklim koşullarına sahip alanlarda gerçekleştirilecek peyzaj tasarımlarında kullanılabilecek, uyumlu süs çimi türleri ile söz konusu bu türlerin görsel özellikleri yönünden rehber niteliğinde bir kaynak oluşturulmuştur. Bu doğrultuda, gerçekleştirilmesi hedeflenen çevre dostu peyzaj tasarımlarında, biyolojik çeşitliliği yükseltmek ve görsel zenginliği arttırmak amaçlarıyla ilgili bitkilerin kullanımını yaygınlaştırmak hedeflenmiştir.

Anahtar Kelimeler: Süsçimleri, yerörtücüler, peyzaj tasarımı, grasses, kurakçıl peyzaj.

Introduction

The plants used in landscape design are classified as trees, shrubs, climbers, ground cover plants, turf grasses, herbaceous plants, and seasonal flowers according to the hierarchy among themselves. Within this classification, ornamental grasses stand in a relatively new place. Although named as grasses, many of the species available on the market do not belong to the Poaceae (Gramineae) family and therefore are not 'true' grasses. But the term 'grass' has become a convenient way to identify a range of plants that share a similar trait: namely, narrow to strap like leaves (Ondra, 2002). Ornamental grasses commonly include sedges, rushes and cattails in addition to true grasses. Some common examples of narrow-leaved perennials grown for their foliage include liriopes (*Liriope* spp.) and sedges (*Carex* spp.) (Ondra, 2002). In examples of contemporary landscape design, grasses are being included in ever increasing numbers. The reasons for this are multiple. Firstly, if they are well chosen and correctly matched to their environment, they can maintain the same compact visual properties all year round and enable the design to achieve a state of permanency. Secondly, they require very little maintenance, which in comparison to other plant types, renders the design more ecologically sound and sustainable. Water consumption is an especially crucial aspect of planting design. And yet, irrigation is regularly applied irrespective of the water requirements of the landscape, utilising irrigation systems that are designed without adhering to the existing water supply, area, vegetation, and soil. This causes a very large amount of water to be wasted (Demirel et al., 2018). With the right plant-based design healthy ecosystems could be created; after all ecosystems constitute the environment in which living beings coexist and interact with non-living beings in order to secure the future generations of natural species (Tülek and Barış, 2014). Lastly, different ornamental grass species add variety, particularly in terms of the colour and movement that they bring to the design.

The lack of Turkish literature on the subject has contributed to limited usage of ornamental grasses in landscape projects in İzmir when it would otherwise have been appropriate to do so. This study's aim was to review these ornamental grass species and compile a guide supported by information on the visual field performance of the plants while exposed to minimal interventions. Therefore, the object was to spread the use of these grasses to increase biodiversity and expand the visual richness of environmentally friendly landscape designs.

Material and Method

In this research, 21 species and their 14 cultivars of 10 grass genera, *Acorus gramineus* 'Ogon' and 'Variegatus'; *Carex comans* 'Bronze'; *Carex morrowii* 'Ice Dance'; *Carex oshimensis* 'Everest' and 'Evergold'; *Carex testacea*; *Cortaderia selloana* 'Gold Band' and 'Silverstar'; *Leymus arenarius*; *Liriope muscari* and *L. muscari* 'Variegata'; *Miscanthus sinensis* 'Flamingo' and 'Zebrinus'; *Muhlenbergia capillaris*; *Ophiopogon japonicus* and *O. japonicus* 'Variegatus'; *Pennisetum viridescens*; *Pennisetum setaceum* 'Rubrum' and *Pennisetum villosum* with *Stipa tenuissima*, were used as the plant material in this study. The plants were chosen based on

their relatively new availability at the nurseries of Izmir therefore their increasing usage in local landscape projects without any structural knowledge.

The species were obtained in pots and were directly planted onto the site in early September 2017. The performance of these ornamental grasses was observed over a four-season period in an open field in Ege University's Bayındır Vocational Training School which is dominated by Aegean climatic conditions (Figure 1 and 2). The species were watered artificially until the planting adaptation to the field was achieved; then, they were left to the natural precipitation until April 2018. With the vegetation period taking off the grasses were irrigated only to prevent excessive drying. If the foreign plants established near the grasses, they were cleared monthly during spring. No visible diseases or pests detected on any of the plants. There was no cutting or pruning carried out at any time of the year. Accordingly, there were no other interventions (i.e. fertilizer applications) involved. During the observation period, the plants' survival in the area together with the visual stability they demonstrated were examined once a week.

Figure 1. *The species examined in the research field – view 1 (Original, 2018)*

Figure 2. *The species examined in the research field – view 2 (Original, 2018)*

Results and Discussion

The information provided here firstly covers the general characteristics of the 21 species and their cultivars in their native environment obtained from previous literature. And then, secondly, how those observed samples reacted in an open field under the Aegean ecological conditions over a period of one year with minimum interventions.

1. *Acorus gramineus* 'Ogon' and *Acorus gramineus* 'Variegatus'

The plant is in the family Acoraceae; thus, it is not a true grass but a rhizomatous perennial, native to wetlands of Southeast Asia. The plant is hardy to -15°C in full sun or part shade. As it is a helophyte it thrives in medium to wet soils and helps to control erosion on water banks. It reaches 15 - 30 cm in both spread and height and develops yellowish flowers in spring but they are insignificant (URL-1, 2019; URL-2, 2019).

A.gramineus'Ogon' features bright yellow leaves with green stripes. All observed samples demonstrated no visible development including no flower production in June. Leaves drying resulted in a non-uniform colour structure. The plants were unable to compete with the foreign plants invading 90% of its plot.

A.gramineus 'Variegatus' features green leaves with cream coloured stripes. The samples demonstrated no visible development other than some flower production in June. Leaves drying resulted in a non-uniform colour structure. The plants were relatively able to compete with a medium rate (60% of the plot) of foreign plant invasion.

2.*Carex comans* 'Bronze'

The plant is in the family Cyperaceae thus it is not a true grass but an evergreen perennial, native to New Zealand. The plant is hardy to -5o C in full sun or part shade. It thrives in moist but well drained soils. It reaches 10 - 50 cm in both spread and height and develops brown flowers in spring but they are insignificant (URL-3, 2019).

Carex comans 'Bronze' features bright bronze coloured leaves. All observed samples demonstrated a fully healthy appearance yet with there was no flower production in June. The development of the plants is adequate with no amount of dried leaves. There was no foreign plant invasion among the *C. comans* 'Bronze' individuals.

3. *Carex morrowii* 'Ice Dance'

The plant is in the family Cyperaceae thus it is not a true grass but an evergreen perennial, native to Japan. The plant is hardy to -15^{o} C in full sun, part shade or full shade. It thrives in moist but well drained soils. It reaches 10 - 50 cm in both spread and height and develops brown flowers in early summer but they are insignificant (URL-4, 2019).

Carex morrowii 'Ice Dance' features green leaves with white stripes. All observed samples demonstrated a fully healthy appearance yet there was no flower production in June. The leaves were inclined to be buried in soil after a heavy rainfall. There was no foreign plant invasion among the *C.morrowii* 'Ice Dance' individuals.

4. *Carex oshimensis* 'Everest' and *Carex oshimensis* 'Evergold'

The plant is in the family Cyperaceae thus it is not a true grass but an evergreen perennial, native to Japan. The plant is hardy to -20$_{o}$ C in full sun or part shade. It thrives in moist but well drained soils. It reaches 10 - 50 cm in both spread and height and develops brown flowers in summer but they are insignificant (URL-5, 2019; URL-6, 2019).

Carex oshimensis 'Everest' features green leaves with white stripes. All observed samples demonstrated a fully healthy appearance with some flower production in June. The growth rate of the plants adequate with no amount of dried leaves. There was no foreign plant invasion among the *C. oshimensis* 'Everest' individuals.

Carex oshimensis 'Evergold' features yellowish white leaves with green stripes. One third of all planted samples died in the field yet those which remained produced some flowers in June. The leaves were inclined to dry and be buried in soil after a heavy rain fall; there was no foreign plant invasion among the *C. oshimensis* 'Evergold' individuals.

5. *Carex testacea*

The plant is in the family Cyperaceae thus it is not a true grass but an evergreen perennial, native to New Zealand. The plant is hardy to -10$_{o}$ C in full sun or part shade. It thrives in moist but well drained soils. It reaches 10 - 50 cm in both spread and height and develops brown flowers in summer but they are insignificant (URL-7, 2019).

Carex testacea features green leaves turning into bright reddish bronze colour. All observed samples demonstrated a fully healthy appearance yet with no flower production in June. The growth rate of the plants was adequate with no amount of dried leaves. There was no foreign plant invasion among the *C. testacea* individuals.

6. *Cortaderia selloana* 'Gold Band' and *Cortaderia selloana* 'Silverstar'

The plant is in the family Poaceae and it is an evergreen perennial grass native to South America. The plant is hardy to -15$_{o}$ C in full sun. It thrives in moist but well drained soils. It reaches 100 - 150 cm in both spread and height. The plant develops 150 cm tall silver coloured striking flowers in summer (URL-8, 2019; URL-9, 2019).

Cortaderia selloana 'Gold Band' (active syn. *C. selloana* 'Aureolineata') features serrulate green leaves with yellow margins. All observed samples demonstrated a fully healthy appearance with few flowers produced in September. The growth rate of the plants was adequate with every individual demonstrating tillering. There was no foreign plant invasion among the *C. selloana* 'Gold Band' individuals.

Cortaderia selloana 'Silverstar' features serrulate green leaves with white margins. All the samples demonstrated a fully healthy appearance with some flower production in September. The growth rate of the plants was adequate with every individual demonstrating tillering. There was no foreign plant invasion among the *Cortaderia selloana* 'Silverstar' individuals.

7. *Leymus arenarius*

The plant is in the family Poaceae and it is an evergreen perennial grass native to Northern Europe. The plant is hardy to -15o C in full sun. It is both a halophyte and a psammophyte; therefore, thrives in saline sandy habitats. The plant, which reaches 10 - 50 cm in spread and 50 -100 cm in height, develops 100 cm tall blue coloured spikes in summer (URL-10, 2019).

Leymus arenarius features striking blue leaves that pale with age. All the samples demonstrated a fully healthy appearance; each of them with flower production in June. The growth rate of the plants was adequate with every individual demonstrating tillering. There was no foreign plant invasion among the *L. arenarius* individuals.

8. *Liriope muscari* and *Liriope muscari* 'Variegata'

The plant is in the family Asparagaceae thus it is not a true grass but an evergreen perennial, native to the Far East. The plant is hardy to -10o C in part or full shade. It thrives in moist but well drained soils. It reaches 10 - 50 cm in both spread and height and develops 30 cm tall purple flowers in autumn like the hyacinth plant (URL-11, 2019; URL-12, 2019).

Liriope muscari features glossy green leaves with slightly yellow margins and *Liriope muscari* 'Variegata' features glossy green leaves with wide yellow margins. All the samples demonstrated a stable appearance with some flower production in September. There were no dried leaves, but they were inclined to get dusty and muddy. The plants were unable to compete with the foreign plant invasion covering 80% of their plot.

9. *Miscanthus sinensis* 'Flamingo' and *Miscanthus sinensis* 'Zebrinus'

The plant is in the family Poaceae and it is an evergreen perennial grass native to the Far East. The plant is hardy to -15^{o} C in full sun. It thrives in moist but well drained soils. It reaches 50 - 100 cm in spread and 100 - 150 cm in height (URL-13, 2019; URL-14, 2019).

Miscanthus sinensis 'Flamingo' features green leaves and develops 100 cm tall pink coloured spikes in summer. All the samples demonstrated an erratic appearance with occasional dry leaves and no flower production in June. There was no foreign plant invasion among the *M. sinensis* 'Flamingo' individuals.

Miscanthus sinensis 'Zebrinus' features green leaves with horizontal yellow bands and develops 100 cm tall brown spikes in summer. All observed samples demonstrated a fully healthy appearance yet there was no flower

production in June. The growth rate of the plants was adequate with every individual demonstrating tillering. There was no foreign plant invasion among the *M. sinensis* 'Zebrinus'individuals.

10. *Muhlenbergia capillaris*

The plant is in the family Poaceae and it is an evergreen perennial grass native to Central America. The plant is hardy to -10^{o} C in full sun or part shade. It thrives in moist but well drained soils. It reaches 50 - 100 cm in both spread and height. *Muhlenbergia capillaris* features green leaves and develops 100 cm tall pink and striking spikes in autumn (URL-15, 2019).

All observed samples demonstrated a copious number of pink flowers in autumn. The plants were adversely affected in winter and showed poor development on site. The leaves were dense, yet weak and occasionally dry. There was some foreign plant invasion among *M. capillaris* individuals which the plant was able to compete with.

11. *Ophiopogon japonicus* and *Ophiopogon japonicus* 'Variegatus'

The plant is in the family Asparagaceae thus it is not a true grass but an evergreen perennial, native to the Far East. The plant is hardy to -10^{o} C in part or full shade. It thrives in moist but well drained soils, reaches 10 - 30 cm in both spread and height. The plant develops 10 cm tall lilac coloured flowers in summer which turns into pea size bright blue fruits hidden within the glossy leaves. (URL-16, 2019; URL-17, 2019).

Ophiopogon japonicus demonstrated a stable appearance, yet they all produced flowers in June. The plants also set fertile seeds. The glossy green leaves were burnt by the sun and inclined to get dusty and muddy. The plants were unable to compete with the foreign plant invasion covering 90% of their plot.

Ophiopogon japonicus 'Variegatus' features narrow green leaves with white margins. All samples demonstrated a stable appearance with limited flower production in June. The leaves were burnt by the sun and inclined to get muddy. The plants were unable to compete with the foreign plant invasion covering 90% of their plot.

12. *Pennisetum viridescens*

The plant is in the family Poaceae and it is an evergreen perennial grass native to the Far East. The plant is hardy to -5^{o} C in full sun and thrives in well drained soils that lack clay. It reaches 50 - 100 cm in both spread and height. *Pennisetum viridescens* features long green leaves and develops 70 cm tall purple spikes resembling a cat tail in autumn (URL-18, 2019).

All observed samples were adversely affected in winter and showed poor development on site. The leaves were weak and occasionally dry. There was some foreign plant invasion among *Pennisetum viridescens* individuals which the plant was able to compete with.

13. *Pennisetum setaceum* 'Rubrum'

The plant is in the family Poaceae and it is an evergreen perennial grass native to Africa and the Middle East. The plant is hardy to 1^{o} C in full sun and thrives in well drained soils that lack clay. It reaches 50 - 100 cm in spread and 100 - 150 cm in height. 'Rubrum'features long burgundy leaves and develops 100 cm tall purple spikes resembling a cat tail in autumn (URL-19, 2019).

All observed samples were adversely affected in winter and no individuals survived to the first spring.

14. *Pennisetum villosum*

The plant is in the family Poaceae and it is an evergreen perennial grass native to Africa. The plant is hardy to 1^{o} C in full sun and thrives in well drained soils that lack clay. It reaches 10 - 50 cm in both spread and height. *Pennisetum villosum* features long green leaves and develops 50 cm tall yellowish green spikes resembling a cat tail in summer (URL-20, 2019).

All observed samples were adversely affected in winter leaving the leaves weak and occasionally dry. Yet the plants showed development on site resulting in full flower production in September. There was no foreign plant invasion among *P. villosum* individuals.

15. *Stipa tenuissima*

The plant is in the family Poaceae and it is an evergreen perennial grass native to Central and South America. The plant is hardy to -5^{o} C in full sun and thrives in well drained but moist soils. It reaches 10 - 50 cm in spread and 50 - 100 cm in height. *Stipa tenuissima* features long green leaves and develops 60 cm tall yellow spikes resembling a feather in early summer (URL-21, 2019). These spikes together with the leaves catch the wind easily and successfully insert movement into the landscape.

All observed samples demonstrated a fully healthy appearance with copious amounts of yellow flowers in June. The growth rate of the plantswas adequate with every individual demonstrating tillering and seeding. There was no foreign plant invasion among the *S. tenuissima* individuals.

Conclusion

The suitability of the species for the landscape design in the Aegean climate was determined based on their survival and maintenance of the visual appearance during the observation period.

- Considering *Acorus gramineus* 'Ogon' and *A. gramineus* 'Variegatus' belong to wetlands they demand water for a typical Aegean climate. The plants being rather short prevented them competing with the foreign plant invasion which in return required regular maintenance. Both plants should be used on

constantly moist environments. Ornamental pebbles or chipped bark etc. could be applied to prevent foreign plants together with leaves being buried in soil.

- *Carex comans* 'Bronze', *Carex oshimensis* 'Everest' and *Carex testacea* seem suitable for Aegean conditions as they demonstrated a healthy appearance all year around with no extra maintenance requirements. Also, *C. comans* 'Bronze' and *C. testacea* added a colour variety to landscapes. They can be followed by *Carex oshimensis* 'Evergold' and *Carex morrowii* 'Ice Dance' if the plants are used with ornamental pebbles or chipped bark etc. to prevent leaves being buried in soil.
- *Cortaderia selloana* 'Gold Band' and *C. selloana* 'Silverstar' seem a suitable grass species for Aegean conditions as both cultivars demonstrated a healthy voluminous appearance all year around and required no extra maintenance.
- *Leymus arenarius* appears a suitable grass species for Aegean ecological conditions as its adaptation was total all year around with no extra maintenance requirements. The plant's striking blue colour added visual variety to the landscape. On account of being both a halophyte and a psammophyte, makes it suited to coastal landscapes. Aging plants may require replacement due to colour degradation but on the other hand the plant producing offspring allowed the fresh blue colour to present continuously.
- *Liriope muscari* and *L. muscari* 'Variegata' could be used with ornamental pebbles or chipped bark etc. to prevent leaves being buried in soil. Both plants required regular maintenance due to their inability to compete with foreign plants.
- *Miscanthus sinensis* 'Zebrinus' seems a more suitable grass species than *Miscanthus sinensis* 'Flamingo' as its adaptation to Aegean ecological conditions was total with no maintenance requirements. Also, when the plant failed to produce flowers, the unusual appeal of the horizontal stripes on its leaves added visual variety to the landscape.
- *Muhlenbergia capillaris* appeared a suitable grass species for three seasons as the plant was adversely affected in the winter yet demonstrated full recovery the following spring. Nevertheless, its striking pink and long flowers added significant colour and movement to the landscape.
- *Ophiopogon japonicus* and *O. japonicus* 'Variegatus' could be used with ornamental pebbles or chipped bark etc. to prevent leaves being buried in soil. As they were both susceptible to burning from the sun, the species can only be used in semi/shaded areas and they require regular maintenance due to failing to compete with foreign plants.
- *Pennisetum setaceum* 'Rubrum', with its long burgundy structure, added colour and movement to landscape yet they failed to survive the winter under Aegean ecological conditions. *Pennisetum villosum* and *Pennisetum viridescens* were unreliable throughout winter with less impressive visual properties.
- *Stipa tenuissima* appeared one of the most suitable grass species for Aegean ecological conditions as its visual properties remained intact all year around. And its light, long and voluminous structure added great movement to the landscape. The plant tended to self-seed which may eventually require some maintenance in its vicinity.

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