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Review

Position and application areas of geophytes within landscape design

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Benefiting from the natural vegetation of the region optimizes the planting design both aesthetically and functionally, and efficient planting is achieved through concomitant utilization of various forms. Geophytes are especially preferred in planting works as natural species due to their superior qualities such as easy growth as well as beautiful and glamorous flowers and plant forms in spring and autumn. They are used in parks and gardens overseas, and their use becomes gradually widespread in landscape design works in Turkey, especially in Istanbul Metropolitan City over the recent years. In this study the importance of geophytes in terms of landscape design was covered, general principles and areas of use were explained, and examples were given from the Istanbul metropolitan city.

Key words: Geophytes, planting, landscape design.

POSITION OF GEOPHYTES WITHIN LANDSCAPE DESIGNS

The plant, which is the most important aspect of landscape design works, is the most important material used for the creation of places, in which one lives or can live. Plants fulfill several major tasks as the main structural elements of green areas in functional, aesthetic and ecological terms. With the beginning of “return to the nature” trend, the use of natural plants instead of culture plants started to gradually increase in planting works.

Alternative use of natural species increases the variety, and brings along planting mobility. Geophytes have a distinct position within the natural species with their underground stems, their durability against unfavorable environmental conditions, their structure as a medical and aromatic plant, their ability to blossom in winter and early spring, their aesthetic and decorative appearance, and the appeal that they give to the parks and gardens in landscape design.

Geophytes have a wide area of use, including but not limited to settlement areas, parks and gardens, arboretums, building entries, garden walls, roadsides and rock gardens.

They give a continuous and colorful appearance to the setting with the combined use along with trees, flowered bushes, annual and perennial herbaceous plants, thanks to their ability to eliminate the monotonousness with the flower colors and forms that they possess (Steinegger et al., 1999; Koyuncu and Yılmaz 2000; Özgün, 2002; Alp and A ur, 2006).

On the other hand many regions within Anatolia present habitats, which are suitable for the growth of geophytes with their various climate features. The source of many geophytes used in European parks and gardens is actually Anatolian mountains. Even though they have had a wide area of use in landscape design applications overseas for many years, their importance in terms of landscape design is a relatively a new discovery for Turkey, and an increase of their use was observed in recent years.

As examples of use for the purpose of promotion and exhibition of our geophytes that originate from various locations in Turkey such as Istanbul’s “Nezahat Gökyi it Botanical Garden”, “Üsküdar Municipality Botanical Garden” and “Bulbous Plants Park” can be given (Figure 1).

They are exhibited within large containers in these venues, and several other examples such as rock gardens, borders, flower beds and other tree and bush types can also be seen. On the other hand it can be seen that many geophyte types such as *Hyacinthus* and

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Figure 1. Exhibition of geophytes, which have been brought from several locations in Turkey (Nezahat Gökyi it Botanical Garden /Istanbul). (Photo: Seyido lu, 2006) .

Figure 2. Use of *Muscari* in flowing masses on the sides of the road (Ataköy coast road/Istanbul) (Photo: Seyido lu, 2007).

Muscari (especially *Tulipa*) have been used in parks, gardens, streets, roads, refuges and flower beds (Seyido lu. 2009).

GENERAL PRINCIPLES OF USE FOR GEOPHYTES IN LANDSCAPE DESIGNS

In a design to be made with geophytes, many factors must be considered, which include flowering period and time, plant height, flower color and size, plant texture and its combination with other plants (Table 1) (Steinegger et al.,1999; Evans, 2005).

While the geophytes can blossom every season, it is possible to classify them into two categories, namely “autumn bulbs”, which are planted in autumn and blossom in spring, and “spring bulbs”, which are planted in spring and blossom in autumn”. Many geophytes blossom in spring. Depending on planting and the climate, they can preserve their flowers from the beginning of February to March or even June. Species such as *Chionodoxa, Ipheion, Narcissus, Scilla* and *Tulipa* blossom in spring; *Allium, Camassia, Galtonia, Dahlia, Iris, Gladiolus, Urgenia* and *Lilium* blossom in spring and summer; *Cyclamen, Eranthis, Galanthus* and *Hyacinthus* blossom in winter; and *Colchicum, Crocus, Stenbergia* and *Nerine* blossom in autumn. Species such as *Crocus* and *Stenbergia* present foliation during or after the flowering; and *Colchicum* presents flowering before the foliation (Halevy, 1990; Rees, 1992; Leeds, 2001; Evans, 2005; Dirik, 2008).

Geophytes create a strong visual impact due to their use in drifts (flowing masses), groups and sets for design applications. Their use in drifts gives an appeal to the area. Small bulbous species such as S*cilla, Crocus* and *Hyacinthus* can be preferred. For instance, *Cyclamen hederifolium* creates a perfect appearance, when used as flowing masses with its green silver figured leaves, and pink and white flowers. Furthermore several geophytes have the tendency to adapt to their new environments, and to naturalize in such environments. They can easily adapt to new places. The types of geophytes, which have this characteristic, are used in drifts or waves. It is possible to achieve a natural looking garden effect with a design that includes spread geophytes. Usually they are preferred in grass fields, wooden areas, shore areas, road sides, slopped areas, pool and riversides and courtyards.

For this purpose, species such as *Allium, Chionodoxa, Crocus, Galanthus, Camassia, Scilla, Iris, Anemone, Narcissus, Fritillaria, Eranthis, Leucojum, Muscari* (Figure 2) and *Ornithogalum* should be used. In case of a large design in wooden areas with broad leaved species, it would be necessary to create transition surfaces to be seen from several points of view (Rees, 1992; Leholm, 1998; Anonymous, 2004; Cornwell and Giles, 2004; Anonymous, 2005; Anonymous, 2006).

Group planting should be preferred in larger areas. For instance *Stenbergia* and *Colchicum* create an impressing look with their yellow color, when used in the form of a shiny yellow bowl. Use of small flowered geophytes in groups in walkways, terraces and entry roads also gives an appeal. Usage of a single color and type should be preferred, since it gives the impression of a larger area and creates a visual impact by providing a uniform color and texture. In larger areas, usage of two or three colors has proven efficient. In such designs, it should be ensured that bulbs of each color are together, that the chosen colors match, and that the colors do not mix with one another.

For instance, preference of white flower types in more sheltered and shady corners is more efficient in terms

Table 1. Flower colors, flowering periods, plant lengths and areas of use in landscaping for several types of geophytes (Seyido lu, 2009).

Genus and species	Flower colour	Flowering time	Plant height (Average/cm)	Areas of use*
Agapanthus *spp.*	Blue,White	Summer	24-36	5,8,9,12
Allium aflatunense	Purple	April-May	60	1,2,3,4,7
Allium giganteum	Purple	May-June	100	3,4,5,10
Allium karataviense	Pimk,Lilac	May-June	25	2,3,4
Allium moly	Yellow	Last spring	10-14	2,5,6,7
Allium neopolitanum	White	April-May	30	2,3,4,5
Allium roseum	Pink	May-June	40	2,3,8
Allium tuberosum	White	Last summer	20	2,3
Anemone blanda	Blue, White, Pink	March-April	15	1,2,4,5,6,8
Anemone coronaria	Blue, White, Pink	March-April	25	4,6,8
Anemone nemorosa	White	March-April	15	4,8
Arum italicum	Green	March-June	45	3,4,6
Arum maculatum	Purple	March-June	45	3
Begonia spp.(tuberli)	Red,White	Summer	30-45	12
Caladium	Green,White	Summer	12-18	8
Camassia spp.	Blue	May	45	4
Canna spp.	Pink,Red	Summer	60-210	8
Crocus chtysanthus	Blue,Yellow,White	February-March	10	1,2,4,5,6,7
Crocus sieberi	Light Blue	March-April	10	1,4,5,6,7
Crocus vernus	Purple,White striped	February-Spril	15	1,2,4,5,6,7
Chionodoxa spp.	Blue	February-March	15	1,2,3,4,5,6,7
Colchicum autumnale	Pink,White	September-October	10-30	2,4,6
Cyclamen coum	Violet,Pink	February-March	10	2,6
Cyclamen hederifolium	Deep Pink, White	August -September	10	2,6
Dahlia	Different colours	Summer	30-240	4,9
Eranthis hyemalis	Yellow	February-March	10	2,6,5
Eremurus sp.	Cream,Yellow	Last spring	40-70	4,9,10
Erythronium spp.	Yellow, White	April-May	30	2,4,6,7
Fritillaria imperialis	Yellow,Orange,Red	April-May	75-100	4,5,7,8,10
Fritillaria meleagris	White,Purple	April-May	25	1,2,4,5,6,7,8
Galanthus spp.	White	January-April	25	1,2,4,5,6,8
Galtonia spp.	Greeny,White	Mid summer	35-45	9
Gladiolus spp.	All colours	Mid summer	12-60	9,11
Hemerocallis spp.	Different colours	Summer	30-90	5,6
Hippeastrum spp.(*Amaryllis*)	Different colours	Early summer	75	4,5,9,10
Hyacinthoides hispanicus	Blue,White,Pink	Mid spring	10-16	2,6
Hyacinthus orientalis	Red,White,Purple	March-April	25	4,5,11,12
Iris spp.	Purple,Light Blue	February-March	10-15	2,4,5,6,10,11
Ixia spp.	White	June-August	30-45	2,9
Liatris spp.	Blue,White	Summer	30-120	4,5
Lilium candidum	White	May	100	4,5,6,8,10,11
Lilium martagon	Red	June-August	100-150	4,5,6,8
Leucojum aestivum	White	April-May	40	2,3,5,6
Muscari armeniacum	Blue	March-July	10-25	2,5,6,8
Muscari comosum	Purple	March-July	10-25	2,5,6,8
Narcissus spp.	Yellow,White	February-May	12,5-20	1,2,3,4,5,8,10
Ornithogalum nutans	White	March-May	30-40	2,4,5
Ornithogalum umbellatum	White	March-May	30-40	2,4,5
Oxalis adenophylla	Pink	June-July	8	2,3,5
Scilla spp.	Blue	February-June	15-30	1,2,3,4,5
Sternbergia lutea	Yellow	January-March	15-20	2,4,5

Table 1. Contd.

Sparaxis	White,Yellow,Purple	Spring-Summer	30-45	4,9
Triteleia laxa	Light Blue	Summer	45	2,4,9
Tulipa spp.	Different colours	May-June	15-40	1,2,4,5,6,10
Zentedeschia aethiopica	White	Early summer	25-35	8,9

* (1: in lawn area, 2: in rock gardens, 3: in natural and artificial lakes and pools, 4: in flower beds, 5: in borders, 6: with trees and bushes, 7: with ground cover plants , 8: in container gardens (in pots or containers), 9: as cut flower, 10: for exhibition and show purposes, 11: in scent gardens and 12: in interiors).

of color balance. Plant length should also be considered in planting. Generally very long geophytes should be used in the back parts of the planting areas, and the shorter ones should be used in the front parts. Usage of long types in corner parts of the gardens also create an effective look (Leeds, 2001; Fech and Rodie 2002; Anonymous, 2004; Anonymous, 2005).

While the planting distances depend on the species, a general distance of 10 to 20 cm should be used. In flowered species such as *Crocus* and *Galanthus*, 100 to 400 bulbs per square meter with distances of 5 to 10 cm should be used; for *Anemone* and *Lilium* (hollandica), *Tulipa* and *Hyacinthus*, 25 to 45 bulbs per square meter with distances of 15 to 20 cm; and in long species such as *Canna* and *Lilium*, 6 to 12 bulbs per square meter with distances of 30 to 40 cm should be used. On the other hand, it becomes necessary to use at least 50 bulbs in small flowered species or at least 12 to 15 bulbs in large flowered species in order to achieve the intended impact in group plantings (Dirik, 2008).

USES AREA OF GEOPHYTES FOR LANDSCAPE DESIGNS

Geophytes can be used in various areas and forms when it comes to landscape designs and arrangements. Geophytes' forms and examples of use can be explained as follows.

Border planting

The arrangements to be made as border planting are amongst the most common areas of use for geophytes due to the presence of a wide selection with numerous types as well as their suitability for planting in various periods. In curbs, the geophytes can create an effective look when used with bush groups and herbaceous species in groups or simply on their own. For instance, it is possible to create wide border in three or four plant groups with long length *Lilium* and *Fritillaria*; or *Fritillaria meleagris*, *Tulipa* and *Narcissus* can create an appealing combination with short length *Muscari armeniacum, Crocus chrysanthus, Galanthus, Chimonanthus paraecox*, *Daphne alpina* and *Sorbus reducta*.

Species that have glamorous flowers in globoid or spiral form such as *Allium, Cammasia* and *Galtonia* are preferred in borders. In borders that are created with perennials, border maintain their vitality in the long term with the use of geophytes that blossom in March or April, and also when the leaves of the geophytes dry, it functions as mulch. A geophyte border made alongside the length of the grass area would also create a color effect for the grass area (Rees, 1992; Anonymous, 2004; Cornwell, 2004; Cornwell and Giles, 2004; Alp and A ur, 2006; Evans, 2005; Anonymous, 2005).

Lawn area planting

In planting to be made in lawn areas, usually species that blossom in spring are preferred. Planting in a singular color or in flowing groups creates and appeals for the garden. It should be ensured in such lawn area geophytes that the lawn would not be mowed until the leaves of the plants turn yellow. Species that blossom early such as *Narcissus* and *Crocus* are ideal plants to be used in lawn areas. While *Crocus* creates a plain view, *Narcissus* provides an appealing effect with its long size, frail petals and light flowers, which swing in the wind. Species such as *Scilla campanulata*, *Chinonodoxa* spp., *Scilla siberica, Corydalis solida* and *Anemone blanda* can also be used in lawn areas.

For the moist areas, species such as *Fritillaria meleagris, Scilla nutans* and *Ornithogalum umbellatum* are recommended, while for the steep sloped areas, where harvesting and care is difficult, species such as *Hemerocallis* are preferred, which have fibrous root systems and attract attention with their leaves and flowers (Leholm, 1998; Evans, 2005; Anonymous, 2005; Alp and A ur, 2006).

Use in natural, artificial lakes and pools

In arrangements made in natural, artificial lakes and pools, species that are suitable for moist conditions such as *Allium* spp., *Arum italicum, Fritillaria meleagris, Leucojum* spp*., Iris siberica, Scilla* spp. and *Chionodoxa* spp. as well as some *Narcissus* species are preferred. While *Arum* spp. is able to create an appealing view with

Figure 3. Use of *Leucojum aestivum* L. with bushes (Nezahat Gökyi it Botanical Garden/Istanbul) (Photo: Seyido lu, 2006).

its leaves that have visible white tracheas as well as spica shaped fruits that follow the flower structures in the form of white paper, it is also able to provide a contrast in autumn with its fruits, which have an flame red color as well as a shape of spica (Leholm, 1998; Anonymous, 2004; Cornwell, 2004; Anonymous, 2005).

Use in rock gardens

In arrangements to be made in rock gardens, species such as *Allium, Camassia, Colcihicum, Eranthis, Fritillaria meleagris, Lilium, Narcissus, Anemone blanda, Chionodxa, Triteliea, Galanthus, Muscari, Leucojum, Scilla* and *Zephyranthes can be used*. Group planting is preferred more in design. For instance short, frail and thin leaved *Allium moly*, *Iris reticulata*, *Tulipa* spp. and *Erythronium* can create quite an appeal, when used with short, bush- like, round and glamorous flowered *Anemone blanda* and *Oxalis adenophylla* (Rees, 1992; Leholm, 1998; Cornwell and Giles, 2004).

Use with deciduous bushes and trees

Geophytes can also be used with deciduous bushes and trees, but it is not recommended to use them with ever-green species, since they would not be able to receive sufficient light. They also create dynamism with the combinations to be made with bushes on the sides of trees with narrow leaves or the lower sides of the trees that are located in areas around the buildings. *Lilium, Anemone, Scilla, Muscari* spp., *Crocus* spp., *Galanthus* spp., *Leucojum* spp., *Camassia* spp., and *Tulipa* spp. are the geophytes, which are suitable to be used with trees and bushes (Figure 3). Use of *Lilium* spp. in summer or of *Colchicum* in autumn with thin formed bushes creates a pleasant impact. In addition it becomes possible to hide the tree trunks with long *Lilium* types.

Anemone blanda and *Anemone ursinum, S. campanulata* and *S. nutans* can be used around or under thick trunked trees. *Cyclamen*, when planted under the trees, does not abstain from the root challenge of the trees and presents a better development. And *Corydalis*, with its purple colors in the appearance of a carpet during the months of April and May, can be used with deciduous trees and in shady areas.

Trees and bushes, which are suitable for use with geophytes, include *Fraxinus, Betula, Quercus*, *Prunus* sp., *Malus* sp., *Cercis, Forsythia, Chaenomeles, etc*. *Mahonia aquifolium*, when used with yellow *Narcissus; Prunus*, when used with *Muscari*; M*agnolia stellata,* when used with *Muscari alba*; *Rosa*, when used with *Narcissus and Scilla*; or C*yclamen*, when used with *Quercus* create a decorative appearance (Leholm, 1998; Sarıba , 1999; Cornwell and Giles, 2004; Anonymous, 2005).

Use in flower beds

With their different colors and scents as well as their long lasting bright flowers, geophytes provide continuity and appeal for a garden with their numerous and various types, which can not be matched by many summer annuals. When the geophyte species, which blossom in spring or summer, are used on their own or in combination with flowers such as *Mysotis*, *Petunia, Tagetes, etc.*, then both the flowering period is extended and complementary color and contrast are achieved. In such combinations the flowering period and height should be closely monitored. Also in flower beds, informal arrangements should be preferred to the formal arrangements, when it comes to the use of geophytes. Species such as *Allium, Anemone, Begonia, Canna, Crocus, Galanthus, Dahlia, Ixia, Scilla, Tulipa* can be used in flower beds. Formal flower beds are used mostly in exhibition and show gardens (Figure 4). For such flower beds *Lilium, Iris* and *Allium* can be preferred (Leholm, 1998; Rees, 1992; De Hertogh and Powell, 1999; Cornwell and Giles, 2004; Anonymous., 2005; Alp and A ur, 2006).

Use in container gardens

Use of geophytes can be preferred in container planting (stationary or movable containers) in urban areas, where green areas are not so common. In small or large containers such as in plazas, in hotel gardens, within offices, in household gardens, planting with geophytes achieve a pleasant and effective view. It should be ensured that the containers receive sufficient light, and the containers should have holes to be used for drainage. If the geophytes are used with bushes and perennial

Figure 4. A flower beds consisting of *Tulipa* and *Muscari* (Emirgan Park/Istanbul). (Photo: Seyido lu, 2008).

plants, then a more powerful color effect can be achieved. Movable containers can also be preferred, since they are removed after the flowering and moved to somewhere else. Geophytes can also be used within pots in interiors or in terraces. Species such as C*aladium, Zantedeshcia, Amaryllis,* H*yacinthus, Tulipa, Narcissus, Colhicum, Dahlia* and *Iris* can be preferred for this purpose. For instance, *Dahlia* with its dense and thick flowers, and *Tulipa systola* and *Colchicum ritchii* with their various flowering periods, unusual leaves and different flower colors are able to create diversity on their own. On a dark surface, white flowered *Galtonia* and *Lilium* can create a very appealing look, similar to the species that have red flowers when used in combination with grey leaved plants (Rees, 1992; Gutterman, 1997; Leholm, 1998; Leeds, 2001; Anonymous, 2005; Alp and A ur, 2006).

Use with ground cover plants

Geophytes can create beautiful combinations when used with ground cover plants. During the design the height relationship between the ground cover plants and the geophyte species should be considered. Ground cover plant species should not be higher than the half of the geophytes. Usually short ground cover plants such as *Ajuga* sp., *Hedera helix* and V*iola* sp. should be preferred. It is possible to create a pleasant look with perennial ground cover plants such as *Cyclamen, Phlox stolonifera* and *Arabis*. The ground cover plants also support the stem of the bulb, and prevent the spattering of the flower with a spatter of the rainwater or irrigation water (Leholm, 1998; Steinegger et al., 1999; Evans, 2005). On the other hand, species such as *Anemone nemorosa, Scilla bithynica, O. umbellatum, Pancratium maritimum, Crocus sativus* and *Iris germanica* can also be used as ground cover plants (Sarıba et al. 2007).

Use as fresh and dry cut flower

Geophytes can also be used as fresh and dry cut flowers. In gardens, which are created for cutting purposes, the visual aspect does not have a place. Planting is recommended to be carried out in series. For this purpose, species such as *Allium, Gladiolus, Lilium, Tulipa, Canna, Muscari, Nerine, Anemone, Caladium, Dahlia, Hyacinthus, Narcissus, Ornithogalum* and *Zandeteschia* can be preferred.

For instance, *Narcissus tazetta* with its large, wide and beautiful flowers, long pedicles and scents; and *Anemone coronaria*, *Ixiolirion tataricum* and *Ornithogalum narbonense* with their durability against arid conditions can all be used as cut flowers (Gutterman, 1997; Leholm, 1998; Steinegger et al., 1999; Evans, 2005).

Use for exhibition and show purposes

Geophytes can also be used for exhibition and show purposes. Species with large and glamorous flowers such as *Allium, Firitillaria, Tulipa, Eremurus, Narcissus, Lilium* and *Hippeastrum* should be preferred. It is recommended that they are used on their own or in groups (Leeds, 2001; Evans, 2005).

Use in scent gardens

Several geophytes types can also be preferred in scent gardens with their pleasant smells in addition to their glamorous flowers. In April and May, *Hyacinthus*, which has aromatic flowers, and *Narcissus*, which has bright yellow flowers and a white paper look, achieves an effective appearance. *Narcissus* can also be used with miniature daffodil.

For summer flowered *Lilium* is one of the indispensable species with its perfect smell. *Lilium candidum, Lilium auratum, Lilium longiflorum, Lilium regale* and *Lilium auratum* are amongst the aromatic *Lilium* species. When bright crème colored *Gladiolus tristis* is used in combination with *Lonicera* and *Matthiola*, they become the center of attraction for pollen-carrying bugs and butterflies. Other species that can be used in scent gardens include *Iris, Ipheion, Acidenthera, Ornithogalum Gladiolus* and *Oxalis* (Relf, 1997; Leeds, 2001; Anonymous, 2004).

RESULTS AND SUGGESTIONS

Geophytes are a group of plants, which remain underground for the majority of the year, brings continuity to the gardens with beautiful and glamorous flowers during spring and autumn. With their use in flowing masses, in groups and in sets, the geophytes are useful

for the creation of wide flower beds, the filling of the gaps between shrubs and bush groups, and the creation of a natural look for the environment.

In landscape design and applications, geophytes can be used in borders, lawn areas, rock and stone gardens, flower beds, scent gardens and interiors. The type to be used for the application should be familiar in terms of flowering period, flower color and size, plant height as well as form and texture. Its ecological requirements as well as cultivation and caring needs should also be considered.

In addition to focusing on the use in landscape applications of the geophytes, which present a natural distribution and have a rich diversity in Turkey; adaption and cultivation efforts should be developed in order to ensure and protect the continuity of the species, and to introduce new species.

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