ANNUAL PLANT COMBINATIONS IN A THERAPEUTHIC LANDSCAPE

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Abstract. While perennials and bulbs go in and out of bloom, annual flower species are adding colour and interest in a landscape with their temporary period of vegetation and decoration. Because annuals need to be replaced every year, requiring more tending the growing season then perennials, this types of ornamental flowering plant are sustainable to be used in therapeutic landscape planting design and horticulture therapy practice. Well-known annuals are frequently used in the landscape planting design, to the disadvantage of other valuable plants whitch are studied in this articole for their morphological decorative characteristics. Analyzing 11 annual flower species in the climate of Cluj-Napoca, can be recommended as a new selection of combination, to obtain a proper layout for a therapeutical garden. Because that the definision of a `healing garden` is still evolving, the selected annual plant combinations are intended to create a garden that provides a holistic experience, a multisensory engagement, distraction from stress and pain.

Keywords: plant combination, decorative, floral plants, healing spaces.

INTRODUCTION

All plants are silent organisms (Beresford-Kroeger, 2004) and landscapes or environments that can boost health, well-being and the construct of a 'therapeutic landscape' is a way of studying and understanding areas that are associated with treatment or healing (Berget et al., 2011). Plants have shown that they bring psychological and perceptual benefits such as increased privacy, which acts in a restorative manner and affect mood (Buta et al., 2013). Garden annuals grow all over the world in all types of climates (Roth, 2011) furthermore, various aesthetic beauties of green spaces and urban landscapes can be permanently improved using vegetation. The large number of existing species and varieties in culture requires detailed knowledge of the main morphological decorative characteristics to be properly associated, completing compositions in accordance with the surrounding landscape (Robinson, 2016). Therefore, the functional aspects of a landscape architecture is in connection with the size of the existing plants and location, influencing the total aesthetic planting design (Walker, 1991).

Walking within nature has been shown to immediately enhance mental well-being but less is known about the impact on physiology and the length of the physiological effect (Gladwell et al., 2016). The use of ornamental plants improve people's health based on the connection between landscape architecture principles and design elements (Hitter et al., 2017). People can find silence from being in natural places, being in contact with nature and looking after plants. By designing a therapeutic landscape, plants can evoke a relaxing, soothing and restoring effect, spreading throughout the body including the sympathetic nervous system (Berget et al., 2011).

Correct plant combinations in relation to landscape architecture taking into account the colours, size, vigor and blooming period, environmental requirements are just a few things to keep in mind to get harmonious and sustainable landscape compositions (Robinson, 2016). Essentially, Social and Therapeutic Horticulture is using gardening and plants to help individuals achieve well-being and this can be done through spending time in gardens

(Bragg et al., 2016) and is viewed as a social exchange achieved by working with and around plants (Relf, 2015).

Annual flower combinations are very attractive, provide vibrant colour for a season – high interest, so their peak flowering period must overlap with the seasons in which the green space is most used or viewed (Marcus et al., 2013). Because annuals invest their energy into one season (Lord et al., 2012) then die back beginning to look unsightly after only a few month (Marcus et al., 2013), this ornamental plants are not contributin to the permanent structure (Lord et al., 2012) of the healing garden. In this case, in the horticulture therapy gardens, planning and planting annuals can be a therapeutic activity (Marcus et al., 2013) too.

MATERIAL AND METHODS

Natural habitats and landscapes provide a whole range of different plants (Berget et al., 2011). The present research study was carried out at the teaching collection of Floriculture discipline at University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania, and it compared the planting material consisted from 11 annual flower species, as follows: *Amaranthus caudatus*, *Argyranthemum frutescens, Centaurea cyanus, Chrysanthemum coronarium, Eschscholzia californica, Iberis umbellata, Lavatera trimestris, Malope trifida, Molucella laevis, Osteospermum ecklonis* and *Verbena hybrida* (Cantor, 2016). There were 11 annuals that were masured and organized in randomized blocks, with 3 repetitions each, each of the plants representing an experimental variant, with 10 plants per repetition (30 plants from each annual ornamental plant). The main morpho-decorative characteristics were correlated in order to achieve the purpose of this experiment, during the vegetation period, the ornamental plants were studied in the summer of 2016-2017. Therefore, we aimed to suggest a correct annual plant combination in relation to therapeutic landscape architecture design, taking into account the colour, size, vigor and blooming period. Results obtained from the present experiment were statistically analysed using Duncan's Multiple Range Test (DMRT) to measure specific differences between selected annuals. During growing season, observations were made regarding to plants growth and development, carried out in the blooming period, when the plants reached the maximum of decoration value in the landscape.

RESULTS

Results regarding the growth and development of the plants, in order to be able to describe in detail each species, biometric observations and measurements were made on the important characters and quality of plants. Based on the data obtained from the studied annual ornamental flower species, recommendations will be done for landscape design, according to these characteristics. The main purpose of the recommendations will be to obtain plant combinations of a great effect. The determinations were made in the blooming period, when the plants reached the maximum of decoration value. The height of the plants (Tabel 1) contributes to the general appearance of the selected species that decorate landscape. Both plant height and bush diameter are biometric elements that give the shape of the plant.

Table 1

Plant height (DMRT)

Cluj-Napoca, 2016-2017

Variant		Plant height			Significance of difference
No.	Species	(cm)	(%)	± d cm	
1	*Amaranthus caudatus*	92.00	141.59	27.02	***
2	*Argyranthemum frutescens*	45.75	70.41	-19.23	00
3	*Centaurea cyanus*	85.50	131.58	20.52	**
4	*Chrysanthemum coronarium*	66.50	102.34	1.52	-
5	*Eschscholzia californica*	35.50	54.63	-29.48	000
6	*Iberis umbellata*	43.00	66.18	-21.98	000
7	*Lavatera trimestris*	73.25	112.73	8.27	-
8	*Malope trifida*	92.50	142.36	27.52	***
9	*Molucella laevis*	51.25	78.87	-13.73	0
10	*Osteospermum ecklonis*	103.50	159.29	38.52	***
11	*Verbena hybrida*	26.00	40.01	-38.98	000
Average of experience		64.98	100	-	-

$LSD_{5\%}$ = 12.19 $LSD_1\%$ = 16.28 $LSD_{0.1}\%$= 21.32

Selecting some of the taller-growing plants, can be achived a new garden layout (Lord et al., 2012), so regarding the studied morphological decorative characteristics for the 11 species, the plants height varies between the limits of 103.50 cm for *Osteospermum ecklonis* and 26.00 cm for *Verbena hybrida*. Taking the average of 64.98 cm and analysing the other variants, noticing that there are species smaller than the average: *Verbena hybrida* 26.00 cm, *Eschscholzia californica* with 35.50 cm, *Iberis umbellata* 43.00 cm, *Argyranthemum frutescens* 45.75 cm and *Molucella laevis* 51.25 cm. The species like *Osteospermum ecklonis, Amaranthus caudatus* and *Malope trifida* are recommended as valuable species in terms of plant height in a planting desing.

Table 2

Development degree of plants at maturity - Diameter of the bush (DMRT)

Cluj-Napoca, 2016-2017

Variant		Diameter of the bush			Significance of diference
No.	Species	(cm)	(%)	± d cm	
1	*Amaranthus caudatus*	79.00	252.07	47.66	***
2	*Argyranthemum frutescens*	32.50	103.70	1.16	-
3	*Centaurea cyanus*	40.75	130.02	9.41	-
4	*Chrysanthemum coronarium*	16.25	51.85	-15.09	00
5	*Eschscholzia californica*	31.00	98.91	-0.34	-
6	*Iberis umbellata*	18.00	57.43	-13.34	0
7	*Lavatera trimestris*	19.00	60.62	-12.34	0
8	*Malope trifida*	20.50	65.41	-10.84	-
9	*Molucella laevis*	21.25	67.80	-10.09	0
10	*Osteospermum ecklonis*	47.00	149.96	15.66	**
11	*Verbena hybrida*	19.50	62.22	-11.84	0
Average		31.34	100	-	-

$LSD_{5\%}$= 10.00 $LSD_{1\%}$= 13.36 $LSD_{0.1\%}$= 17.49

Table 2 summarizes the data about the degree of plants at maturity and it can be seen that the diameter of the bushes varies from 16.25 cm at *Chrysanthemum coronarium* to 79.00 cm at *Amaranthus caudatus*. Taking the mean of the dimension character that is 31.34 cm, it can be seen that there are species with a smaller bush diameter than the other species: *Malope triphida* with 20.50 cm, *Lavatera trimestris* with 19.00 cm, *Chrysanthemum coronarium* with 16.25 cm, *Iberis umbellata* with 18.00 cm, *Verbena hybrida* 19.50 cm, *Molucella laevis* 21.25 cm and *Eschscholzia californica* 31.00 cm.

The analysis of this data reveals that the studied species are statistically insignificant in terms of the diameter of the bushes.

The data summarized in Table 3 regarding the degree of plants at maturity, the diameter of the flower, are processed by the analysis of variance. From the table it can seen that the diameter of the flower varies from 3.00 cm at *Molucella laevis* to 21.50 cm at *Amaranthus caudatus*.

Table 3

Summary results – Flower diameter (DMRT)

Cluj-Napoca, 2016-2017

Variant		Flower diameter			Significance of difference
No.	Species	(cm)	(%)	± d cm	
1	*Amaranthus caudatus*	21.50	335.34	15.09	***
2	*Argyranthemum frutescens*	5.38	83.84	-1.04	-
3	*Centaurea cyanus*	3.63	56.54	-2.79	000
4	*Chrysanthemum coronarium*	3.50	54.59	-2.91	000
5	*Eschscholzia californica*	3.58	55.76	-2.84	000
6	*Iberis umbellata*	3.45	53.81	-2.96	000
7	*Lavatera trimestris*	8.25	128.68	1.84	*
8	*Malope trifida*	8.00	124.78	1.59	*
9	*Molucella laevis*	3.00	46.79	-3.41	000
10	*Osteospermum ecklonis*	4.25	66.29	-2.16	00
11	*Verbena hybrida*	6.00	93.58	-0.41	-
Average		6.41	100	-	-

$LSD_{5\%}$= 1.54 $LSD_{1\%}$= 2.06 $LSD_{0.1\%}$= 2.70

Analyzing the data, there are several species with a higher score than the mean of the flower diameter character such as: *Centaurea cyanus* (56.54%), *Chrysanthemum coronarium* (54.59%), *Iberis umbellata* (53.81%), *Verbena hybrida* (93.58%), *Eschscholzia californica* (55.76%), *Argyranthemum frutescens* (83.84%) and *Osteospermum ecklonis* (66.29%). Additionally, there are species with a higher percentage than the average: *Amaranthus caudatus* (335.34%), *Lavatera trimestris* (128.68%) and *Malope trifida* (124.78%). The *Amaranthus caudatus* annul species, followed by *Lavatera trimester*, proved to be the most valuable in terms of flower diameter. This character is desirable in the improvement of plants by aiming to obtain flowers with the greatest possible size.

The number of shoots per plant is a morphological character that has a major importance for the overall appearance of the bushes giving it a decorative and aesthetic character. The data on the number of shoots are summarized in Table 4. It can be seen that the number of shoots ranges from 4.70 avarege number of shoots at *Malope trifida*, to 1.50 at *Osteospermum ecklonis*.

Table 4

Number of shoots (DMRT)

Cluj-Napoca, 2016-2017

Variant		Number of shoots/plant			Significance of difference
No.	Species	(avarege number of shoots)	(%)	± d	
1	*Amaranthus caudatus*	6.50	81.48	-1.48	-
2	*Argyranthemum frutescens*	10.00	125.36	2.02	-
3	*Centaurea cyanus*	6.75	84.62	-1.23	-
4	*Chrysanthemum coronarium*	7.50	94.02	-0.48	-
5	*Eschscholzia californica*	12.00	150.43	4.02	*
6	*Iberis umbellata*	5.00	62.68	-2.98	-
7	*Lavatera trimestris*	5.50	68.95	-2.48	-
8	*Malope trifida*	6.75	84.62	-1.23	-
9	*Molucella laevis*	6.25	78.35	-1.73	-
10	*Osteospermum ecklonis*	15.50	194.30	7.52	***
11	*Verbena hybrida*	8.00	100.28	0.02	-
Average		7.98	100	-	-

$LSD_{5\%}$= 3.54 $LSD_{1\%}$= 4.73 $LSD_{0.1\%}$= 6.20

Deviations from the mean expressed by relative size show that *Malope trifida* deviates mostly negative (59.54%) and the species *Osteospermum ecklonis* deviates mostly positive (194.30%). From the statistical point of view, the only difference is recorded at *Osteospermum ecklonis* and *Eschscholzia californica* which shows a significantly positive difference. All other species are statistically insignificant in this character - number of shoots. Table 5 presents the selected annual plants flowering phenology (Cantor, 2018; Lord et al., 2012; Toma, 2009; Dumitras et al., 2008), because, designing with nature, a landscape architecture project must be in accordance with the decoration and the blooming time, shape and colour of the ornamental plants.

Table 5

Blooming time of studied annual plants

No.	Species	Decoration time												Habitat
		Spring			Summer			Autum			Winter			hight
		J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	(cm)
1	*Amaranthus caudatus*													60-100
2	*Argyranthemum frutescens*													50-100
3	*Centaurea cyanus*													40-80
4	*Chrysanthemum coronarium*													30-60
5	*Eschscholzia californica*													30-60
6	*Iberis umbellata*													25-35
7	*Lavatera trimestris*													60-100
8	*Malope trifida*													60-100
9	*Molucella laevis*													80-100
10	*Osteospermum ecklonis*													10-50
11	*Verbena hybrida*													10-30

The green space layout design always has to be in harmony with the entire existing environment. According to the presented listed aesthetic characteristics (form, colour, texture) of the studied annual flower species, planting can be designed based on the principles of therapeutic landscape. A well designed landscape architecture green space proposal, can have many purposes for the benefit of people for whom the space is addressed. Plants also provide for a range of physical and social activities and the opportunity for users to demonstrate caring and nurturing behavior (Marcus et al., 2013).

The presented planting design annual flower species combination (fig. 1.) is composed by *Argyranthemum frutescents* (20%), *Molucella laevis* (10%), *Chrysanthemum coronarium* (50%) and *Iberis umbellate* (20%). Planting design theory must provide a visual analysis of the aesthetic sense, for an alternative scenario in planting design practices (Yılmaz et al. 2018). This layout concept can be desinged in an organic pattern, based on colour, texture, morphological traits and decoration period. A landscape can be constructed by using *Chrysanthemum coronarium* and *Argyranthemum frutescents* for a yellow patern from spring to autumn, *Iberis umbellata* for a complementary contrast violet colour and *Molucella laevis* for the interesting leave texture and green colour, imposing height over other species.

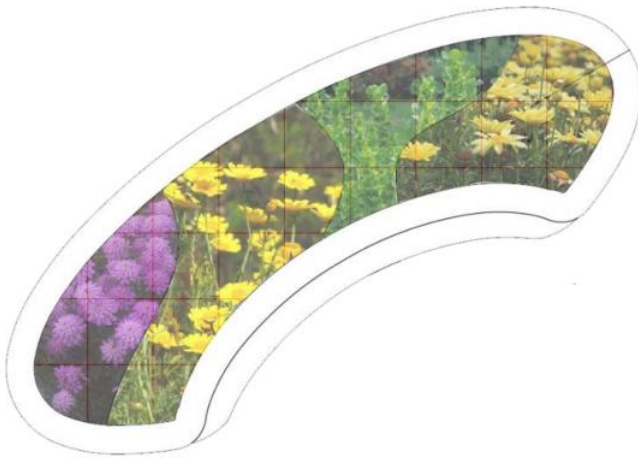

Figure 1. Planting design with annual flower species combination, sourse: original.

DISCUSSIONS

Based on the acquired results, the studied annual flower species and the detailed growing instructions that will be recommended for the design of green spaces. Desirable qualities of annuals plants were chosen according to morphological traits, in order to obtain floral compositions of a great effect. These qualities are:

- Addressing all of the senses;
- Interactiv interaction;
- Colour and texture;
- Different size and shape;
- Atractive planting design;
- Continued attention on landscape (https://www.thrive.org.uk/Files/Documents/G4L%20Resource%20Book%2040pp%20LR%20final.pdf, 2012).

By using in the therapeutic landscape planting design the studied 11 annual flower species (*Amaranthus caudatus, Argyranthemum frutescens, Centaurea cyanus, Chrysanthemum coronarium, Eschscholzia californica, Iberis umbellata, Lavatera trimestris, Malope trifida, Molucella laevis, Osteospermum ecklonis* and *Verbena hybrida*), they can be intergrated in horticulture therapy as activities. According to the practical guide to setting up a community gardening project for people affected by mental ill health, these can be organized by taking into account the four seasons of the year: spring - seed sowing, summer - watering especially pots full of flowers, picking flowers and creating displays, autumn - sweeping and raking leaves and removal of summer bedding, and in winter planning work for next year and preparing new beds (https://www.thrive.org.uk/Files/Documents/G4L%20Resource%20Book%2040pp%20LR%20final.pdf, 2012).

The selected 11 annual plant combinations are intended to create a garden that provides a holistic experience, a multisensory engagement, distraction from stress and pain, and supports psychological equilibrium. So, a healty and attractive planting design in a garden is essential for promoting the health and well-being of the users (Marcus et al., 2013).

CONCLUSIONS

As a result of the research carried out in the Teaching collection (Floriculture discipline) of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, on the main morpho-decorative traits of 11 species of annual plants, it can be drawn the following conclusions:

- The height of the studied annual species presented in Table 1 is between 26.00 cm for *Verbena hybrida* and 103.50 cm for *Osteospermum ecklonis*.
- In terms of the diameter of the bush, wich can be seen in Table 2, is particularly noticeable at *Amaranthus caudatus* that has a diameter of 79.00 cm, while *Chrysanthemum coronarium* has only 16.25 cm.
- The diameter of the flower is a character that basically depends on the appearance of the whole flower, with *Amaranthus caudatus* species having the largest diameter of inflorescence (21.50 cm) and the smallest width of the flower is represented by *Iberis umbellata* (3.45 cm).
- As regarding the number of shoots, in Table 3 are differences between species, the first is *Osteospermum ecklonis* with the avarege number of shoots 15.50 and the last is *Malope trifida* 6.75.
- The colour of the flowers is varied covering a wide range of colours from pink (*Osteospermum ecklonis*) to purple (*Malope trifida, Lavatera trimestris*) passing through the whole chromatic area regarding to Table 5.

These annuals are recommended to be extended to private gardens, used for green areas and horticulture therapy gardens. So, planting is one of the most important aspect of a therapeutical garden and ass they do in all green spaces, the selection and placement of the plants carry a significance of providing respite, memory enhancement and engagement (Marcus et al., 2013).

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