Cumhuriyet Üniversitesi Fen Fakültesi
Fen Bilimleri Dergisi (CFD), Cilt 38, No. 2 (2017)
ISSN: 1300-1949

Cumhuriyet University Faculty of Science
Science Journal (CSJ), Vol. 38, No. 2 (2017)
ISSN: 1300-1949

http://dx.doi.org/10.17776/cumuscij.308379

Sustainable Landscaping with Turfgrasses

Songül SEVER MUTLU[1], Ceren SELİM[1*]

[1]*Akdeniz University, Faculty of Architecture, Department of Landscape Architecture, 07070, Antalya*

Received: 24.08.2016; Accepted: 11.04.2017

Abstract. Turfgrasses are an important component of the landscape adding social, physical, and economic value to our lives. The demand for green space in densely populated urban areas continues to rise. However, the general public where turfgrass exacerbate pressure on available water resources, are prone to develop a negative environmental perception for turfgrass. In general, turf sites of urban cities cause considerable water consumption and therefore is not considered sustainable. But many turfgrass species have the ability to survive for extended periods without water. There are many strategies to reduce irrigation and other management inputs on turfgrasses and hence to alleviate pressure on fresh water resources caused by landscaping. Using native and well adapted grass species may offer sustainable solution. Interest is in the rise among landscape managers for native plants in urban landscaping in recent years. Because of dry summers, limited water, high temperature stress and salinity, it is both expensive and challenging to maintain traditionally used cool-climate grasses not well adapted to Mediterranean region. Therefore, several warm-climate turfgrass species/cultivars were compared for their drought resistance and adaptability to the region. To develop native bermudagrass cultivars, bermudagrass genotypes were collected from the Mediterranean region of Turkey and were characterized for drought tolerance and turf qualities. Results from these studies indicated that several turfgrass species/cultivar and native germplasms offer great potential for use in sustainable urban landscapes in semiarid climates.

Keywords: Native plants, warm-climate grass, Mediterranean, drought

Çim Bitkileriyle Sürdürülebilir Peyzajlar Oluşturulması

Özet. Çim alanlar, sağladıkları sosyal fiziksel ve ekonomik değerlerle peyzaj alanlarının önemli bileşenlerindendir. Yoğun yerleşimlerin yaşandığı kentsel alanlarda yeşil alanlara duyulan ihtiyaç artmaya devam etmektedir. Ancak, çim alanların su kaynakları üzerinde baskı oluşturduğuna dair genel bir kanının varlığı, çim bitkileri üzerinde de negative bir çevresel algının oluşmasına neden olmaktadır. Çim bitkilerinin genellikle su kaybına neden olduğu kanısından dolayı uygun olarak nitelendirilmemektedir. Fakat birçok çim türü bu kanının aksine uzun dönem susuz hayatta kalma yeteneğine sahiptirler. Çim alanların sulama ve diğer yönetim girdilerinin azaltılması ve su kaynakları üzerindeki baskının hafifletilmesi için birçok strateji mevcuttur. Yerel ve adaptasyon kabiliyeti yüksek çim türlerinin kullanılması uygun bir çözüm yolu olarak görülmektedir. Son yıllarda kentsel alanlarda doğal türlerin kullanılması konusunda artan bir ilginin varolduğu bilinmektedir. Sıcak geçen yaz mevsimi, kıt su kaynakları, kuraklık ve tuzluluktan kaynaklanan stres dolayısıyla serin-iklim çim türleri Akdeniz iklimine iyi adapte olamamaktadır. Bu nedenle, Akdeniz bölgesinde kurağa dayanımı ve adaptasyon kabiliyeti yüksek sıcak iklim çim tür/çeşitleri tercih edilmelidir. Yerel Bermuda çimi çeşitlerinin geliştirilmesi için, Türkiye'nin Akdeniz Bölgesi boyunca Bermuda çimi genotipleri toplanmış ve kurağa dayanımları, kaliteleri belirlenmiştir. Bu çalışmalardan elde edilen sonuçlar göstermektedir ki, yarıkurak iklimlerde sürdürülebilir peyzajlar oluşturmak için çok sayıda çim bitkisi türü/çeşidi ve gen kaynaklarının kullanılması büyük potansiyeller sunmaktadır.

Keywords: Yerel bitkiler, sıcak iklim çim türleri, Akdeniz, kuraklık

INTRODUCTION

Turfgrasses have been used to enhance living environment by humans for centuries [1]. With the functional, recreational and aesthetic contributions, turfgrasses have become an important component of the urban landscapes. Some of the environmental and functional benefits of growing turfgrasses include rain water entrapment and ground water recharge**,** protection against soil erosion, dust

* Corresponding author. *Email address:* cerenselim@akdeniz.edu.tr

 ©2016 Faculty of Science, Cumhuriyet University

prevention, soil improvement and restoration, carbon dioxide sequestering, enhanced heat dissipation, and reduction in noise and glare [2]. In addition, turfgrasses can enhance social harmony, work productivity, physical health and mental wellbeing of people by providing a suitable environment for a range of recreational and social activities [2-5]. A number of psychological, social and behavioral research demonstrated that the availability of accessible and attractive green spaces is an integral part of urban quality of life [6, 7]. As the demand for green space in densely populated urban areas continues to rise, the benefits of turfgrasses are even more pronounced [8].

Despite these benefits, a negative environmental perception for using turfgrasses in urban environments has developed over the past two decades by general public especially within the countries where drought is an occasional or regular occurrence [9]. Claims that turfgrass utilizes excessive water and contaminates the environment with chemical residues have led to this negative public perception and replacement of turf area by alternative landscapes, such as xeriscaping, and replacement of natural turf with artificial turf in some countries [10, 11]. The forms of landscaping with increased proportion of hardscapes and semi-hardscapes may be aesthetically pleasing and require minimal inputs for maintenance, such as water however, they fail to provide many positive environmental benefits of turfgrass [12]. Besides, such designs by absorbing large amounts of energy and then radiating that heat energy back into the surrounding area can create heat sinks [12]. The use of artificial turf in place of natural turf has been proposed for sport fields to reduce management inputs. Despite the many improvements, synthetic turf poses serious health problems for users due to rapid heat build up to dangerous level on a hot summer day and the potential exposure to lead and other heavy metals [11, 13, 14].

Significant progress has been made both in water usage by turfgrass [15] and the management of pesticide and nutrient leaching from turfgrass [16] over two decades. Thus, as indicated by Higginson and McMaugh (2008), there is no justifiable scientific basis for the negative press inflicted on turgrasses in the media [11]. Research on various land use types compared with turfgrass indicates that sediment and nutrient losses from urban and turfgrass systems is considerably less than losses from agricultural and forest systems [17]. It was also indicated that most pesticides currently used in turfgrass present relatively low risk for groundwater contamination [15]. As stated by Beard and Kenna, (2008) a healthy turfgrass system provides considerable protection against leaching due to high levels of organic matter and associated microbial activity which serve to immobilize and degrade applied pesticides and nitrates [15]. With respect to water consumption, turfgrass is often considered as wasting water in minds and therefore is not considered sustainable [18]. However as indicated by Johnson (2008) turfgrass does not require inordinate amounts of water and instead often requires less water than some agricultural crops, even in arid regions [19]. A study undertaken in residential landscapes in Florida investigated the water use rates of two contrasting residential landscapes, a monoculture of St. Augustine grass (Stenotaphrum *secundatum* cv. 'Floratam') turfgrass lawn, and an alternative presumed resource-conservative ornamental mixed-species landscape [20]. The authors found that in year four, the mature turfgrass landscape required less than two-thirds of the irrigation that the mixed-species landscape required.

There are many strategies to reduce irrigation and other management inputs on turfgrass and hence to overcome perceived negative environmental impacts. Using drought hardy native and well adapted grass species for a given region is one of them [19, 21] which can lead to a significant reduction in the need for watering, mowing and fertilizing [11]. Native grasses are better adapted to low maintenance conditions especially in the semiarid and arid regions, can tolerate stressful conditions in a number of ways and brings the serenity and beauty of native grassland communities closer to home [19]. Therefore, the interest in the use of native plants in urban landscapes has been increasing among landscape

managers. The use of alternative waters (municipal recycled, untreated household grey, or other low quality water) for turfgrass irrigation is indicated as another way of conserving potable water especially in dry regions and in highly populated metropolitan areas where water is limited [15].

Antalya province located along the Mediterranean coastal region of Turkey leads in number of golf courses; natural turfgrass sports fields (soccer fields), sod production, and other maintained turf areas. For concerns over water availability, turf areas especially golf courses in Antalya are also receiving serious negative environmental criticism recently. Sustainable turfgrass management approaches are being investigated in Turkey. In the following sections such studies and progress made toward turf sustainability in urban landscapes of coastal Mediterranean region of Turkey are highlighted.

Case Study 1: Adaptation and Drought Resistance Assessment of of Warm-season Turfgrasses in the Mediterranean Region

Traditionally cool-climate turfgrasses such as perennial ryegrass (*Lolium perenne*) and tall fescue (*Festuca arundinaceae*) are the dominant species used as turf in the Mediterranean region of Turkey and similar regions of neighboring countries [22, 23]. The cool-climate species, like tall fescue, require significant amounts of water and fertilizer for a green, dense stand [24]. However, due to dry summer, limited water, high temperature stress, high soil pH and salinity, it is expensive and challenging to maintain traditionally used cool-climate grasses not well adapted to Mediterranean region. Increasing the adaptive range of warm-climate grasses has been reported as a strategy for water conservation [10]. Compared to cool-climate grasses, the warm-climate species require about 45% less water [25], exhibit greater drought tolerance [26] and possess a higher nitrogen (N) use efficiency under a wide range of adaptation to soil conditions depending on the species [27, 28]. Two separate studies were conducted to assess the adaptation and drought resistance of six warm-climate turfgrass species and several of their cultivars to Mediterranean growing conditions of Turkey during 2006 and 2007 [29, 30]. Information of this nature was lacking and would be helpful to landscape managers working in the region. The warm climate turfgrass species studied were bermudagrass (*Cynodon dactylon*), buffalograss (*Buchloë dactyloides*), zoysiagrass (*Zoysia japonica*), bahiagrass (*Paspalum notatum*), seashore paspalum (*Paspalum vaginatum*), and centipedegrass (*Eremochloa ophiurioides*). Tall fescue was included as a cool-climate turfgrass species for comparison. For the drought study the fully established turfs were subjected to drought stress for 90 day, followed by resumption of irrigation for recovery of the turfs [30]. Among the summary points of the adaptation study, bermudagrass, bahiagrass and seashore paspalum established faster and extended growing season by retaining their green color 15 d or longer than the rest of the warm-season in the fall [29]. Seashore paspalum, bermudagrass, buffalograss, and zoysiagrass exhibited acceptable turfgrass quality for 7 months throughout the growing season. Tall fescue, a cool-climate turfgrass species, did not survive summer heat stress necessitating reseeding each year in fall. Results showed that warm-climate species have great potential for summer and fall utilization in the Mediterranean region where they perform better than cool-climate species commonly used in the region, especially when heat and water limitations exist.

Bermudagrass and buffalograss exhibited superior drought resistance as demonstrated by lower leaf firing and better shoot recovery values, with an acceptable turfgrass quality up to 30 day under drought stress that can be utilized for water-efficient turf management under the Mediterranean environment [30]. Tall fescue was unable to recover from the drought stress in the same study. Short and Colmer (2007) also demonstrated the opportunity for water conservation when warm-climate turfgrass species were used under Mediterranean-like climate in Australia [31].

Case Study 2: Making use of native turfgrass species

This project focused on collecting and evaluating Turkish *Cynodon* genotypes for turf quality and drought tolerance. Mediterranean region was shown to be within the center of diversity for bermudagrass. Results of the study showed that a large genetic variation in drought resistance exist among bermudagrass genotypes native to the region. Some of these genotypes were found to be superior to commercial bermudagrass cultivars for their drought resistance, quality and color, indicating a genetic potential for the development of native bermudagrass cultivars. Thus, a follow up project has just been initiated recently with the aim of developing turf type drought resistant bermudagrass cultivars for use in water-efficient landscaping under Mediterranean environment.

In addition to drought resistance, there is a considerable need for the evaluation of grasses for their suitability for salt tolerance for urban landscaping in salt-affected areas. Similar to the coastal regions of the world, rapidly developing Mediterranean coastal areas of Turkey suffering the problem of seawater contamination of freshwater wells due to overuse of freshwater aquifer. Many local and federal governments encourage or require use of secondary, saline water sources such as reclaimed water, brackish water, in addition to implementing restrictions and/or penalties on potable water use for landscape irrigation [32, 33, 34]. Therefore, there is a need for salt-tolerant turfgrass cultivars. In light of the need, native bermudagrass germplasms collected from the Mediterranean region will also be screened for salt tolerance and promising ones will be used for development of salt tolerant bermudagrass cultivars. The interest in using alternative water resources for irrigation of turf is also increasing in Turkey. Some golf clubs began utilizing reclaimed water sources for irrigation. In addition, some clubs converted their green on the course to seashore paspalum, a highly salt tolerant species. Maintaining turfgrasses with poor quality water can provide benefits by filtering pollutants and reducing the dependence on potable water resources [10]

In conjunction with the use of the drought tolerant native or well adapted cultivars for a given environment, the use of improved irrigation systems can lead up to 40 % water savings compared with conventional irrigation techniques [11]. Many golf courses in the Mediterranean region uses improved irrigation systems that apply water only when it is required by use of *in situ* soil moisture monitoring systems. Pathan et al.(2003), demonstrated that use of the soil moisture sensor-controlled turf irrigation system saved 100 L of water from leaching per square meter during a summer period of 154 days in Western Australia [35]. The study to determine irrigation schedule in the Mediterranean of Turkey showed that bermudagrass can be sustained with watering rate of 50-75% of evaporation seasonally [36]. Similar water efficiency was reported by Short and Colmer (1999) from Perth in Western Australia. They reported that warm season grasses could maintain acceptable growth and color with only 50-60% of available water [37].

Since water use by a turfgrass can be altered substantially by any changes in management practices [15], it is important to identify optimal sustainable turfgrass management system which require less inputs under Mediterranean conditions for various species and cultivars. Specific cultural practices can be used to decrease water use in urban landscapes, including mowing height and frequency, turfgrass nutrition and turfgrass irrigation. Secondary cultural practices, such as plant growth regulators also influence potential water conservation [15]. The main objective of plant growth regulator (PGR) application to turfgrasses is to restrict leaf growth and the subsequent need for frequent mowing and watering. Severmutlu et al. (2012) showed that mowing can be reduced over 60 % for most warm-climate turfgrass species with PGR application in summer under Mediterranean conditions. This in turn would reduce the need for water and fertilizer [38].

CONCLUSION

Demands for parks, sports fields, and other recreational space in urban areas continues to rise. To meet increasing green space need without imposing pressure on limited water sources, it is crucial to develop and to use water efficient native turfgrass cultivars and/or well adapted species for the region. In conclusion, bermudagrass and buffalograss species/cultivars possess superior drought resistance with higher turfgrass quality, which can be used for water-efficient landscaping under the Mediterranean environment. In addition, seashore paspalum is recommended for their superior salt tolerance and adaptability to the region. These results will be helpful to landscape managers seeking to manage and recommend suitable warm-climate turfgrass species and cultivars for water conservation for the Mediterranean region. Future research on the long-term performance of these species under different fertilization, mowing height, and irrigation regimes including reclaimed water sources should also be considered to develop specific maintenance recommendations for a given species under Mediterranean environment. With the use of native and well adapted drought resistant species such as bermudagrass, buffalograss in conjunction with the best management practices, improved irrigation technologies, it may be possible to sustain turfgrasses in urban landscapes with full benefits under Mediterranean climates.

REFERENCES

[1]. Beard, J. and Green, R.L. (1993) 'Turfgrass and Golf Course benefits-A Scientific Assessment', in USGA Green Section Record, 23(3), 26-30.
[2]. Beard, J. and Green, R.L. (1994) 'The role of turfgrasses in environmental protection and their benefits to humans' in J.Environ. Qual. 23, 452-460.
[3]. Maller, C., Townsend, M., Brown, P. and Leger, St. L. (2002) Healthy Parks Healthy People - The Health Benefits of Contact with Nature in a Park Context – A Review of Current Literature. Deakin University and Parks Victoria. Social and Mental Health Priority Area Occasional Paper Series 1. 86pp.
[4]. Ulrich, R.S. (1984) 'View through a window may influence recovery from surgery', Science, 224, 420-421.
[5]. Pretty J, Peacock J, Hine R, Sellens M, South N and Griffin M. (2007). 'Green Exercise in the UK Countryside: Effects on Health and Psychological Well-Being, and Implications for Policy and Planning' in Journal of Environmental Planning and Management, 50(2), 211-231.
[6]. Herzele, A.V. and Wiedemann, T. (2003) 'A monitoring tool for the provision of accessible and attractive urban green spaces' in Landscape and Urban Planning 63, 109–126.
[7]. Hartig, T., Evansb, G.W., Jamnerc, L.D., Davisd, D.S. and Garling, T. (2003) 'Tracking restoration in natural and urban field settings', in Journal of Environmental Psychology 23, 109–123.
[8]. Richardson, M.D., Karcher, D.E., Hignight, K.W. and Rush, D. (2009) 'Turfgrass cultivars for water limited Environments' in Proceedings from the International Workshop on Summer Dormancy in Grasses-coping with increasing aridity and heat under climate change, April 6-8, Ardmore, OK.
[9]. Robbins, P. and Sharp, J. (2003) 'Producing and consuming Chemicals: The moral economy of the American lawn' in Economic Geography, 79, 425-451.
[10]. Cisar, J.L. (2004) 'Managing Turf Sustainably, New directions for a diverse planet' in Proceedings of the 4th International Crop Science Congress,26 Sept-1 Oct, Brisbane, Australia.
[11]. Higginson, R. and McMaugh, P. (2008) 'The Environmental, Social, Economic and Health Benefits of Turfgrasses' A literature Review in Final Report, Project No.TU07034, Horticulture Australia LTD.
[12]. Rogers, W. (1991) 'Turf's Role in Today's Multi-use Landscape Designs – An Architect's Viewpoint' in Journal of Environmental Turfgrass 3(1): 3.

[13]. Denly, E., Rutkowski, K. and Vetrano, K.M. (2008) A Review of the Potential Health and Safety Risks from Synthetic Turf Fields containing Crumb Rubber Infill. New York City Department of Health and Mental Hygiene, New York, USA. 200pp.
[14]. Health Alert Network (2008) Potential Exposure to Lead in Artificial Turf: Public Health Issues, Actions and Recommendations. Health Alert Network Press Release of June 18th.
[15]. Beard, J.B and Kenna, M.P. (2008) Water Quality and Quantity Issues for Turfgrasses in Urban Landscapes. Iowa: Council for Agricultural Science and Technology Special Publication, No.27, 298pp.
[16]. Clark, J.M. and Kenna, M.P. (2000) 'Fate and Management of Turfgrass Chemicals', in ACS Symposium No.743, the American Chemical Society, Washington, DC., pp.480.
[17]. Koehler, F.A., Humenik, F.J., Johnson, D.D., Kreglow J.M., Dressing, S.A. and Maas, R.P. (1982) Best management practices for agricultural nonpoint source control: II. Commercial Fertilizer. USDA Coop. Agree. 12-05-300-472. USEPA Interagency Agree. AD-12-F-0-037-0. North Carolina Agric. Ext. Serv., Raleigh, NC.
[18]. Jenkins, V.S. (1994) The lawn: A history of an American Obsession. Washington, D.C.: Smithsonian Institute Press.
[19]. Johnson, P.G. (2008) Native Grasses as Drought-Tolerant Turfgrasses of the Future, in Pessarakli, M. (ed.) Handbook of Turfgrass Management and Physiology. Boca Raton, FL:Taylor and Francis Group.
[20]. Park, D. M., Cisar, J. L., Snyder, G. H., Erickson, J. E., Daroub, S. H. and Williams, K. E. (2005) 'Comparison of actual and predicted water budgets from two contrasting residential landscapes in South Florida', in International Turfgrass Society Research Journal, 10, 885-889.
[21]. Martin, P.M. (2004) 'The potential of native grasses for use as managed turf' in Proceedings of the 4th International Crop Science Congress. Brisbane, Australia. 26 Sep to 10 Oct, pp.17.
[22]. Croce, P., De Luca, A., Mocioni, M. Volterrani, M., and Beard, J.B. (2001) 'Warm-season turfgrass species and cultivar characterizations for a Mediterranean climate' in Intl. Turf. Soc. Res. J. 9:855–859.
[23]. Volterrani, M., Grossi N., Pardini,G., Miele, S., Gaetani, M. and Magni, S. (1997) 'Warm season turfgrass adaptation' in Italy. Intl. Turfgrass Soc. Res. J. 8, 1344–1354.
[24]. Bormann, F.H. and Balmori, D. (1993) Redesigning the American lawn. Yale Univ. Press, Binghamton, NY.
[25]. Brian, I., Bravdo,B., Bushkin-Harav, I. and Rawitz, E. (1981) ' Water consumption and growth rate of 11 turfgrasses as affected by mowing height, irrigation frequency, and soil moisture', Agron. J. 73, 85-90.
[26]. Beard, J.B. (1989) 'Turfgrass water stress: Drought resistance components, physiological mechanisms, and species-genotype', in Takatoh H. (ed.). Proc. Intl. Turf Res. Conf., 6th, Tokyo, 31 July–5 Aug., Jpn. Soc. Turfgrass Sci., p. 23-28.
[27]. Moore, K.J., Boote, K.J. and Sanderson, M.A. (2004) Physiology and developmental morphology, In, Moser L.E., Burson, B.L. and Sollenberger, L.E. (eds.). Warm-season (C4) grasses. Monogr. No. 45. Amer. Soc. Agron., Crop Sci. Soc. Amer., Soil Sci. Soc. Amer., Madison, WI. pp. 179-216.
[28]. Wedin, D.A. (2004) C4 Grasses: Resource use, ecology and global change,.In, Moser L.E., Burson, B.L. and Sollenberger, L.E. (eds.). Warm-season (C4) grasses. Monogr. No. 45. Amer. Soc. Agron., Crop Sci. Soc. Amer., Soil Sci. Soc. Amer., Madison, WI. pp. 15-50.
[29]. Severmutlu, S., Mutlu, Shearman, R.C., Gurbuz, E. Gulsen, O., Hocagil, M., Karaguzel, O., Heng-Moss, T., Riordan, T.P. and Gaussoin, R.E. (2011a) 'Establishment and Turf Qualities of Warm-season Turfgrasses in the Mediterranean Region' in Horttechnology, 21(1), 67-81.
[30]. Severmutlu, S., Mutlu, N., Gurbuz, E. Gulsen, O., Hocagil, M., Karaguzel, O., Heng-Moss, T., Shearman, R.C. and Gaussoin, R.E. (2011b) 'Drought Resistance of Warm-season Turfgrasses Grown in Mediterranean Region of Turkey' in Horttechnology, 21(6), 726-736.
[31]. Short, D.C. and Colmer, T.D. (2007) 'Development and use of a variable-speed lateral boom irrigation system to definewater requirements of 11 turfgrass genotypes under field conditions' in Aust. J. Exp. Agr. 47, 86–95.
[32]. Council of Australian Goverments (2004) National Water Initiative, http://www.coag.gov.au/meetings/25060/#nwi.

[33]. Florida Department of Environmental Protection (2010) Applicable rules for reuse projects, chap.62-610, Reuse of reclaimed water and land application, http://www.dep.state.fl.us/water/reuse/index.html.
[34]. California State Water Resources Control Board (2011) Porter-Cologne Act provisions on reasonableness and reaclimation promotion. California Water Code, Section 13552-13577, http://www.swrcb.ca.gov/water_laws/index.html.
[35]. Pathan, S.M., Barton L. and Colmer, T.D. (2003) Evaluation of a soil moisture sensor to reduce water and nutrient leaching in turf. Project TU02006, Horticulture Australia Limited, Sydney, Australia.
[36]. Emekli, Y., Bastug, R., Buyuktas, D. and Emekli, N.Y. (2007) 'Evaluation of a crop water stress index for irrigation scheduling of bermudagrass' in Agricultural Water Management, 90, 205-212.
[37]. Short, D. and Colmer, T. (1999) 'Update on WA water use study: a comparison of eleven turfgrass genotypes during the summer in Perth' in Australian Turfgrass Management 1(5), Oct-Nov 1999.
[38]. Severmutlu, S., Mutlu, Gurbuz, and Riordan, T.P. (2012) 'Effects of Seasonal Application of Trinexapac-Ethyl on Warm-season Turfgrass Species growth under Mediterranean Environment' submitted.