Comparison of Turfgrass & Landscape Plants Water Usage to Grass Reference Evapotranspiration

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Background

To promote water conservation and improve irrigation management, the Northern Colorado Water Conservancy District conducted a study comparing the water usage of fifteen commonly sold and planted shrubs used in many residential and commercial landscapes to the water required for maintaining a typical turfgrass lawn in Colorado. This study was partially funded by the Rocky Mountain Sod Growers Association and The United States Bureau of Reclamation Eastern Colorado Area Office. The purpose of the study was to gain knowledge that would assist landscape managers better manage water resources and provide information that could be used to create proper irrigation schedules.

Materials and Methods

The site for the study was located at the former headquarters of the Northern Colorado Water Conservancy District (District) in Loveland, Colorado. On site was a weather station surrounded by a well-watered and maintained Kentucky Bluegrass lawn and a hedge of Three-leaf Sumac. The data collected from this weather station was used to calculate grass reference evapotranspiration (ET_O) using the ASCE Standardized Penman-Monteith equation.

Fifteen shrubs were selected for the study as a result of a survey of local landscape architects and nurserymen as to the plants most often specified and sold. The fifteen plants shown in the photos in the appendix had three replications each with the results showing the average of the three plants included in the study. The plants were located in a shrub bed mulched by cedar mulch and were irrigated daily using drip irrigation. The shrubs were 5 gallons in size and were installed and established in weighing bucket lysimeters that were placed on load-cell platforms. The load cells were connected to a Campbell Scientific data logger and were continuously monitored with readings averaged every fifteen minutes throughout a 24-hour day. Irrigation took place each night after 11 pm. Plant water usage was calculated by measuring the difference in weight a few hours after irrigation to allow for drainage of excess water and before the next scheduled irrigation. The difference in weight was then converted into inches of water used by the plant for that day. The growing season covered the time when the plants first started leafing out in early May until the fall of leaves in late October.

The plants selected for the study with the abbreviations used in presenting the data in the graphs, are as follows:

- Blue Chip Juniper (BCJ)
- Compact Burning Bush (CBB)
- Cistena Plum (CiP)
- Frobel's Spirea (FrS)
- Dwarf Korean Lilac (KoL)
- Peking Cotoneaster (PeC)
- Redtwig Dogwood (RtD)
- Snowmound Spirea (SmS)
- Blue Mist Spirea (BMS)
- Comp. Am. Cranberrybush (CCB)
- Cranberry Cotoneaster (CrC)
- Gold Drop Potentilla (GdP)
- Common Purple Lilac (Lil)
- Pygmy Redleaf Barberry (PRB)
- Russian Sage (RuS)

Periodically the plants were measured throughout the growing season to determine the area covered by the plant. The widest and narrowest dimensions were used to calculate the square footage covered by the plant. The average of the readings for the growing season was used to calculate the water usage of the plant on a "per-square-foot-equivalent" basis and this was then used to compare to the water required by Kentucky bluegrass turf on a per-square-foot basis. Numerous methods were considered to try and compare water usage between the plants and turfgrass, but the "per-square-foot-equivalent basis" was selected because if landscape plants were not used then most likely a turfgrass lawn would cover the ground.

Results

The study was established in 2001 and concluded in 2003. The data for the growing season of 2003 was used because the plants well established in the lysimeters, were the largest of the three years in the study and the weather pattern of 2003 was fairly typical in regards to calculated ET and rainfall received during the growing season. The year 2002 was a drought year and was the hottest and driest in recorded history. The datum for each plant was statistically analyzed and the data for the individual plants were combined to give an average for the plant species as can be shown in the example for Graph 1. Individual plant curves are shown in Graph 2 that shows the variability in plant water usage for the species throughout the growing season. Using the ASCE Standardized Penman-Monteith grass reference equation to calculate ET_O, Graph 3 shows that the average crop coefficient (Kc) for the fifteen plants used in the study was .56 with a range of .34 to .79. A typical bluegrass lawn receiving traditional management practices of watering, mowing and fertilizing would have a crop coefficient of .81 although the range for cool season grasses can be from .72 for low maintenance turf to .90 for turfgrass that needs to be of highest quality such as a sports field. As a rule of thumb a typical bed of landscape plants will require about two-thirds the amount of water as a Kentucky bluegrass lawn.

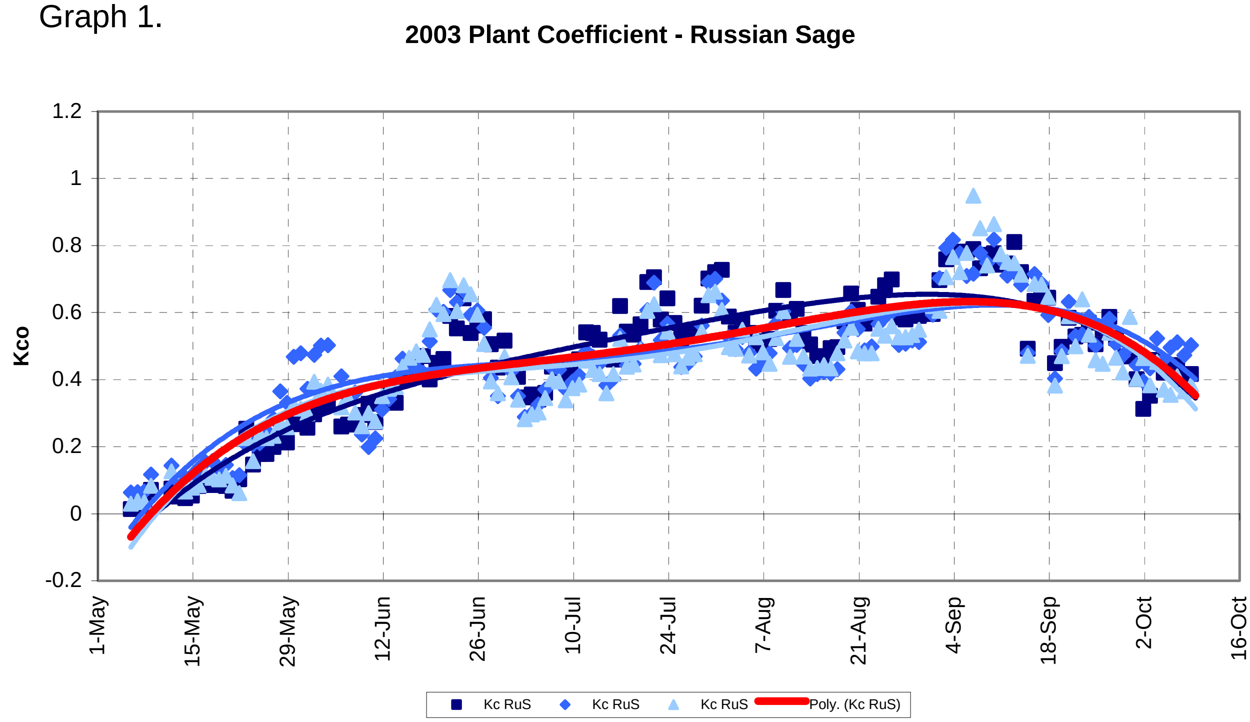
Conclusion

This study provides some useful information about the relative plant water usage compared to a typical bluegrass lawn in regards to irrigation scheduling. The plant term "drought tolerant" does not mean "water hating". Some of the plants in the study are typically found on most lists of plants that should be used in xeriscapes because of their ability to survive on a minimal amount of water. However, these plants grew tremendously when they had all of the water and nutrients that they desired. Other plants that are considered "water misers" such as Froebel's Spirea are not necessarily drought tolerant, meaning that they don't require much water, but they need water to survive. So the concept of drought tolerance is a plant's ability to withstand and survive drought conditions when they exist but that should not be interpreted as a "water-hating" plant. Many times "native" (with the idea that native means drought tolerant) plants are recommended for use in the urban landscape but are used in ways that are not "native". For example the density in which the plants might be planted may not be typical of how they grow naturally or they are taken from an environment that receives a fair amount of rainfall and moisture and placed into a climate condition that is quite different than the "natural" environment they would typically grow and vice versa. Some common plants used in the urban landscapes that are considered "native" but are often planted in environments quite different than their native conditions would include Aspen trees, Ponderosa Pines, Pinon Pines and Potentilla among others.

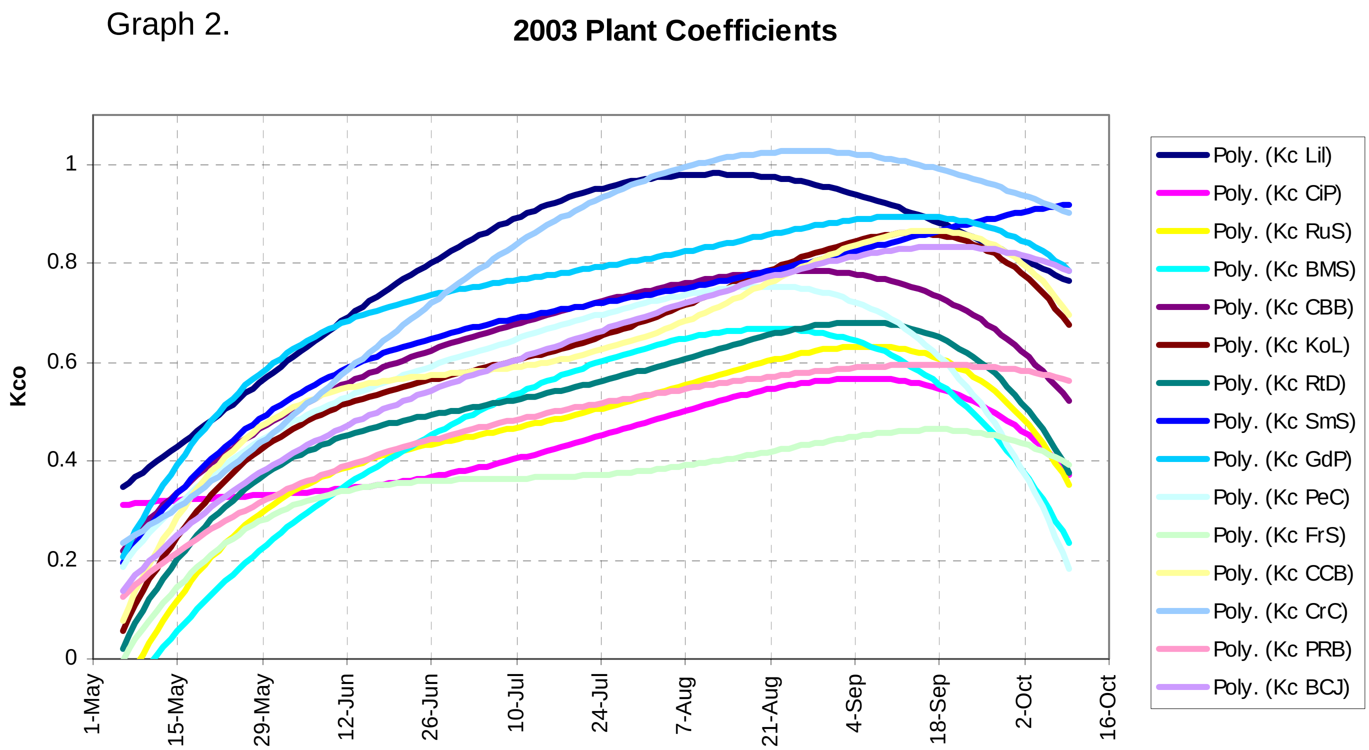
At the conclusion of this study, a few weaknesses in the study have been identified to offer suggestions on how a future study might be conducted to gain some important additional knowledge. A few of the other considerations and suggestions for improvement include:

- Growing the plants in the lysimeters confines the development of the root system and does not allow the plant to grow as it would naturally. Therefore the lysimeters facilitated measuring the amount of water applied, drained and used by the plant, but it was not an ideal condition for the plant.
- The planting medium for the plants was a nursery soil mix that is great for growing container plants, but it may not accurately reflect how the plants would do in natural soils.
- The plants were provided all the water and nutrients that they needed but it didn't allow for how they might do in less than ideal conditions. If the plants were able to grow in natural soils and their root systems develop in a more natural way then we could consider how they might do with less than ideal amounts of water and test them in a deficit irrigation management regime.
- The plants were grown as individual specimens, which doesn't necessarily reflect how they would be planted in a landscape bed. Determining how much water a landscape bed requires is different than measuring the water required by a single plant.
- To gain a better understanding of plant water requirements a longer study is needed. Questions that still need to be answered are how much water does a plant need when it has reached maturity compared to the water required when it is young and growing actively? How frequently should the plants be irrigated compared to turfgrass lawns? How much water is required when there are multiple plant canopies covering the same soil area and the root systems are intertwined?
- Is there a better to way to compute plant water need besides on a "per-square-foot-equivalent basis"?

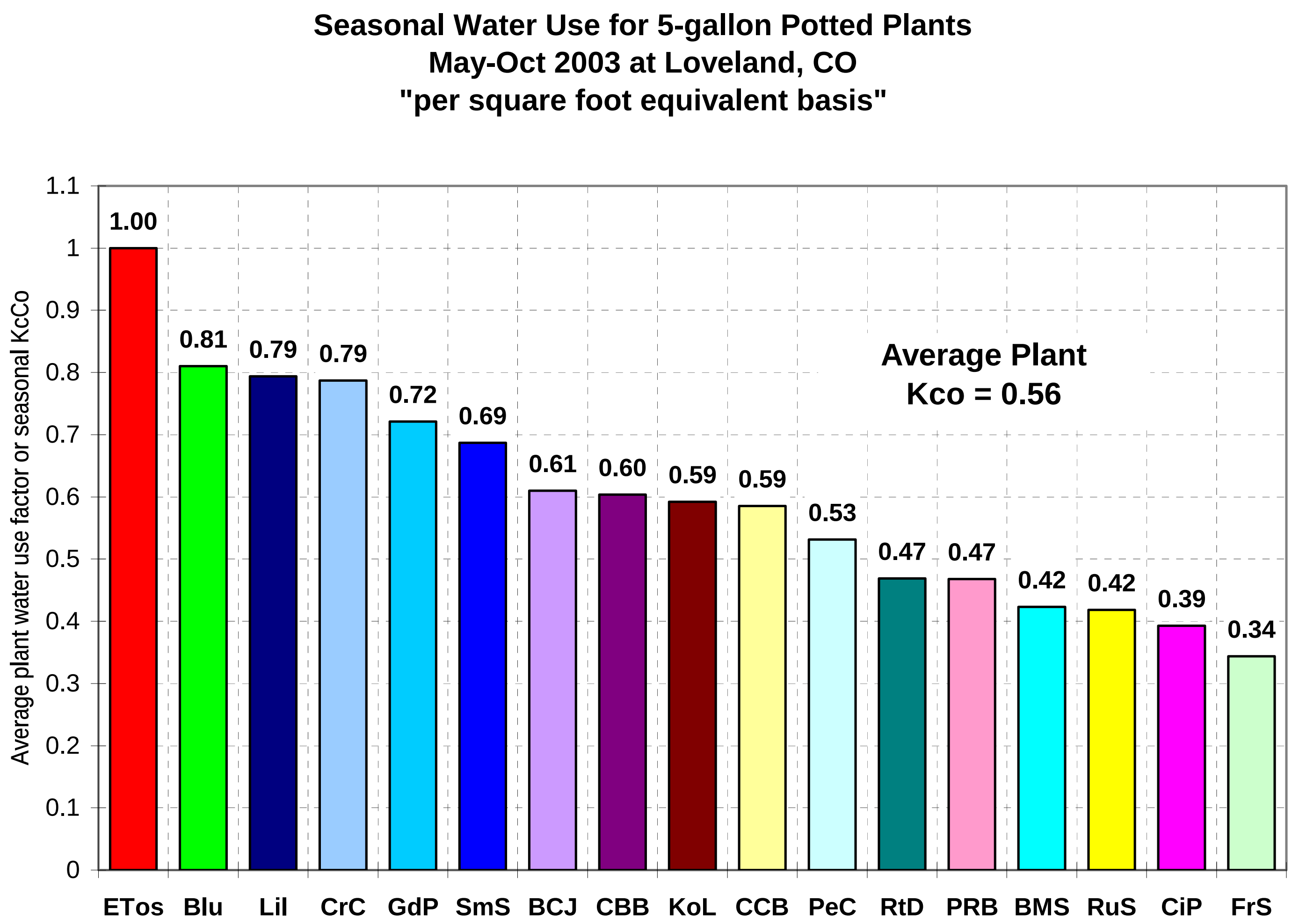
Graph 1.



Graph 2.



Graph 3.



Seasonal Water Use for 5-gallon Potted Plants
May-Oct 2003 at Loveland, CO
"per square foot equivalent basis"
Average plant water use factor or seasonal KcCo
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.00
0.81
0.79
0.79
0.72
0.69
0.61
0.60
0.59
0.59
0.53
0.47
0.47
0.42
0.42
0.39
0.34
Average Plant
Kco = 0.56
ETos
Blu
Lil
CrC
GdP
SmS
BCJ
CBB
KoL
CCB
PeC
RtD
PRB
BMS
RuS
CiP
FrS

Appendix

Lysimeter on Load Cell Weighing Platform

3 replicates of 15 commonly planted landscape shrubs