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Helen Muntz
Utah State University

Kelly Kopp
Utah State University

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Abstract

Irrigation system evaluations, such as the Water Check program instigated by Utah State University Extension, promote water conservation in the landscape by equipping homeowners with the necessary information to maximize their irrigation systems' efficiencies. Retrospective evaluation indicated that the Water Check program positively affected participants' understanding of irrigation and system maintenance concepts and their water-saving behaviors. As well, 48% of participants reported that they had reduced their landscape water use after participating in the Water Check program. These findings suggest that an in-person, on-site irrigation education program provides worthwhile results for drought-prone regions.

Keywords: water conservation, irrigation behavior, homeowner education

Helen Muntz
Assistant Professor
helen.muntz@usu.edu
@helmuntz

Kelly Kopp
Professor and
Extension Specialist
kelly.kopp@usu.edu
@kopptweets

Utah State University
Logan, Utah

Introduction

In response to drought conditions and population growth throughout the United States, researchers have focused on water conservation, particularly in the area of outdoor water use (Kopp, Cerny-Koenig, & Lopez, 2007; McCammon, Marquart-Pyatt, & Kopp, 2009; Seymour & Bauske, 2009). Concurrently, irrigation system evaluations have been used as a tool for encouraging water conservation in the landscape through education on irrigation methods for commercial, industrial, and institutional water users (Kopp et al., 2007; Seymour & Bauske, 2009) as well as homeowners managing residential landscapes (Moss, Haase, Vogel, Boyer, & Martin, 2013).

Irrigation systems are often inefficient due to factors such as poor timing of water application and improperly maintained equipment (e.g., clogged, broken, or mismatched sprinkler heads). These factors may result in uneven water application, or poor distribution uniformity, which is a common factor leading to overwatering in landscapes (Kjelgren, Rupp, & Kilgren, 2000). Moreover, people often set automatic irrigation system schedules according to water requirements during the peak water demand period for turfgrasses, leaving schedules unchanged throughout the growing season. Data obtained from previous irrigation system evaluations in Utah indicate that residents with automatic irrigation systems overwater their landscapes by 50% (Glenn, 2010). Furthermore, people use 53% of Utah's potable water to irrigate landscapes (Glenn, 2010). These data in Utah mirror findings from studies conducted in other states (Haley, Dukes, & Miller,

2007; St. Hilaire et al., 2008). Water supply and demand issues are prevalent across the United States due to factors such as population growth, increased standard of living, and drought conditions, particularly in arid western states (St. Hilaire et al., 2008). Therefore, addressing drought conditions and water supply and demand requires education. Do education initiatives, such as irrigation system evaluation, adequately increase homeowner awareness and promote water conservation? We implemented an irrigation evaluation program and investigated the educational results of the program via retrospective surveys.

Utah State University Extension has provided fact sheets for homeowners describing how they can determine their own distribution uniformity using "catch cups" (Kopp, Allen, & Goodspeed, 2013). Utah homeowners can rent these catch cups at their local Extension office. However, few people request the use of catch cups. Therefore, recognizing a need for other options for addressing overwatering, Extension collaborated with water conservation districts in offering free sprinkler system evaluations for homeowners, or "water checks," to educate the public and address these issues.

Program Description

The Water Check program in Utah began in 1999 when Extension worked with cities and water conservancy districts in support of statewide water conservation efforts during an ongoing drought. Initially Extension provided training for water conservancy district Water Check program employees while water conservancy districts facilitated scheduling and assisted with program promotion. Over the years the program has been running, some districts have been able to hire sufficient staff to run the program themselves. Others have continued to contract with Extension to provide the service to clientele. Historically, only Utah citizens living within the service areas of the water conservancy districts could register for a water check. We added the Water Check program in 2015 for Cache County, Utah, which did not have a water conservancy district and is the location of the study described herein.

An education program involving on-site irrigation system evaluations for each program participant, Water Check is unique in that it provides in-person education along with detailed explanations of water check results. A water check includes an irrigation system evaluation and a suggested customized irrigation schedule, adjusted according to site-specific landscape water requirements. Participants receive this suggested irrigation schedule along with an individualized report identifying landscape and irrigation system problems, descriptions of these problems, suggested maintenance for a more efficient system, and web links for locating qualified irrigation specialists having Qualified Water Efficient Landscaper certification.

Water Check Procedure

Trained Extension interns and master gardener volunteers conduct the following procedures for each homeowner participant:

- Perform an irrigation system walk-through to map out the system and identify maintenance issues.
- Execute a distribution uniformity test, or "catch cup test."
- Create a customized irrigation schedule.
- Produce a Homeowner Report of Water Check.

- Review the irrigation schedule and homeowner report with the participant.

Extension Intern and Master Gardener Training

To qualify Extension interns and master gardener volunteers to conduct water checks, Extension agents and specialists provide training, conducted over 2 days. During the Water Check program training, the interns and volunteers complete the following activities:

- Attend classroom instruction covering plant material and irrigation, the catch cup test procedure, calculation of precipitation rates, distribution uniformity, and irrigation system scheduling based on test calculations.

- Read a Water Check program manual that provides irrigation system basic information, including information about spray head types, irrigation system design, maintenance issues, time clocks, soil testing, water needs based on plant type, and use of evapotranspiration charts and distribution uniformity checks to calculate irrigation schedules.

- Participate in hands-on training at local parks and county properties that includes practice conducting walk-throughs, practice using different types of time clocks, and practice performing catch cup tests and establishing irrigation system schedules.

Methods

According to Raidl et al. (2004), retrospective surveys serve as "an effective way to measure self-reported behavioral change" ("Implications" section, para. 1). Therefore, we evaluated knowledge gained by and behavioral changes in Water Check program participants in Cache County using a retrospective "post-then-pre" design.

Recall bias may occur in any educational program and in retroactive surveys because participants may incorrectly perceive an inflated preeducation understanding. However, some studies have indicated that when compared to surveys conducted before and after an educational program, retrospective surveys provide more accurate data for evaluating knowledge gained from the program. For example, according to Pratt, McGuigan, and Katzev (2000), participants judge their own prior knowledge more harshly after participating in a program than they do when filling out a pretest. Furthermore, retrospective surveys are an effective tool for measuring self-reported behavior because incomplete pre- or postprogram data sets and wasted data sets are eliminated (Raidl et al., 2004).

Participants received the retrospective post-then-pre survey instrument through email via Qualtrics software. Participants who did not provide email addresses received the same survey instrument through postal mail in paper form with a return envelope. Participants received the survey instrument in October of the same year that they had received the Water Check program service. We calculated percentages of increase by comparing the percentages of participants indicating "yes" in response to knowledge questions and "often" or "all of the time" in response to behavioral questions with regard to their statuses before and after receiving the Water Check program education. We also included a yes-no question to collect data on whether participants had reduced their landscape water use after receiving their water checks.

Results

Fifty percent of Water Check program participants completed the survey.

As indicated by the average overall positive percentage of change values shown in Table 1, close to 50% of respondents reported having more knowledge after receiving their water checks as compared to before receiving their water checks. Results for specific types of knowledge were positive as well. For instance, the percentage of change value for the survey item "I can identify maintenance issues with my sprinkler system such as sunken, tilted, or clogged heads" was 48%.

Table 1.

Changes in Participants' Irrigation Knowledge from Before to After Water Check Program

	2015 (*n* = 23)			**2016 (*n* = 27)**		
	Responding *yes*			**Responding *yes***		
Question	**Before**	**After**	**Change**	**Before**	**After**	**Change**
I can identify maintenance issues with my sprinkler system such as sunken, tilted, or clogged heads.	26%	74%	48%	22%	70%	48%
I know that when adjusting my watering schedule throughout the season, the amount of water applied at each watering stays the same, while the number of days between watering changes.	39%	96%	57%	40%	85%	45%
I understand that cycling, or adding multiple start times to each zone on watering days, allows water to penetrate deeper into the soil and minimize run off or ponding.	43%	100%	57%	37%	100%	63%
I understand that head-to-head coverage for sprinkler heads allows more even and efficient coverage.	48%	96%	48%	41%	89%	48%
I know that mixed sprinkler head types within one zone can cause over- or underwatering.	48%	87%	39%	41%	85%	44%
Average			49.8%			49.6%

Survey participants also indicated having positive changes in irrigation behaviors after receiving a water check, as shown in Table 2. That is, their habits of checking their sprinkler systems for repairs each season, adjusting their sprinklers according to weather needs, and implementing cycling (or applying the regular amount of water in two or three shorter increments for reduced leaching, ponding, or runoff) increased by an average of 26% in 2015 and 33% in 2016. In addition to positive behavioral changes represented by the data shown in Table 2, 48% of participants indicated that they had reduced their landscape water use because of participating in the Water Check program.

Table 2.

Changes in Participants' Irrigation Behaviors from Before to After Water Check Program

	2015 (*n* = 23)			2016 (*n* = 27)		
	Responding *often* or *all of the time*			Responding *often* or *all of the time*		
Question	**Before**	**After**	**Change**	**Before**	**After**	**Change**
I check my sprinkler system for repairs and improvements each season.	61%	65%	4%	56%	70%	14%
I adjust my sprinkler system each month according to weather and turfgrass water needs.	30%	65%	35%	30%	70%	40%
I follow the cycling method.	34%	74%	40%	33%	78%	45%
Average			26.3%			33.0%

Discussion

The Water Check program provided in Cache County, Utah, in 2015 and 2016 included intensive, in-person education on landscape irrigation operations in the home environment. Studies of similar programs focusing on irrigation system evaluations have indicated that training through workshops results in increased knowledge of efficient landscape irrigation practices as related to water conservation among homeowners (Moss et al., 2013) as well as larger scale business landscapes (Kopp et al., 2007). The results of our evaluation of the Water Check program support these findings.

Irrigation behaviors are difficult to change and require homeowner awareness and education. Homeowners may not know how much water they are applying to their landscapes and may have a lack of understanding of landscape water requirements based on plant material and climate (Bremer, Keeley, Jager, Fry, & Lavis, 2012). Our Water Check program survey results indicate that providing in-person and on-site irrigation system evaluations with suggested irrigation scheduling and thorough reports can help residents reduce their landscape water use and potentially save money on fertilizer application and water bills through a free educational program. Though many Water Check program participants indicated that they reduced landscape water use, further investigation would identify actual changes in water use. Using billing data for several years prior to and at least 1 year after performing water assessments, researchers could calculate actual changes in irrigation behavior. Future research could address this question, providing data to help people manage landscapes across arid regions and identifying solutions for the demands of growing populations.

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