these systems, volunteers may shop for other opportunities that will meet their needs.

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Assessing Consumer Knowledge and Use of Landscape Plant Health Care and Integrated Pest Management Practices through a Computer-based Interactive Survey

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ADDITIONAL INDEX WORDS. cluster analysis, IPM, PHC, Philadelphia Flower Show, segmentation, survey

SUMMARY. Attendees at the 2001 Philadelphia Flower Show participated in an interactive-quiz-formatted survey on touch-screen computers to determine their knowledge and use of plant health care (PHC) and integrated pest management (IPM) practices. Participants answered 15 questions in three categories: 1) PHC practices (criteria for proper plant selection, correct planting practices, and reasons for mulching and pruning); 2) IPM practices (insect identification, plant and pest monitoring, and maintenance of records on pests found and treatments applied to their landscape plants); and 3) demographic and sociographic questions to aid in characterizing the survey population. Over half of the participants (58%) were interested in

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gardening and a majority (77%) were interested in protecting the environment. Most participants (66%) were between 36 and 60 years of age with a mean age of 47 years, 76% lived in and owned a single-family home, and greater than half (56%) had never purchased professional landscape services. Most recognized PHC criteria for proper site selection, although not all environmental site characteristics were recognized as being equally important. Nearly half (49%) identified the correct planting practice among the choices offered; while an equal number of participants chose among the several improper practices listed. Although reasons for mulching were properly identified by the respondents, excess mulching around trees was considered a proper planting practice by over 39% of the participants. When questioned about IPM practices, a majority reported that they identify pests prior to treating them (71%) and that they scouted their landscapes (82%). However, only 21% kept records of the pests that they had found and the treatments that they applied for those pests. Participants' responses were further examined using cluster analysis in order to characterize the participants and identify meaningful consumer knowledge segments for targeting future extension programming. Three distinct segments were identified: 1) horticulturally savvy (69% of the participants), 2) part-time gardener (25% of the participants), and 3) horticulturally challenged (6%). At least 47% of the horticulturally savvy and part-time gardeners correctly answered plant health care questions (44% of the total survey participants). These two segments included more individuals who were interested in gardening and protecting the environment and are potential targets for future PHC and IPM extension education programs. In contrast the horticulturally challenged recorded no interest in or opinion on gardening or protecting the environment. It is apparent that a majority of consumers are learning and employing PHC and IPM concepts. Proper site selection, planting practices, and mulching along with record keeping and pest identification proficiency remain key educational areas to be developed. Although not all gardeners are well versed in all subject matter, a basic knowledge of PHC and IPM is being demonstrated.

Over the past 10 years, concepts and practices of IPM and PHC have been recognized by the landscape industry and among extension educators as useful and complementary tools for promoting healthy landscapes (Ball, 1994; Nielsen, 1990). IPM monitors pest problems and employs a combination of management tactics including biological, chemical, cultural, and mechanical methods to reduce or maintain pest populations below damaging threshold levels (Nielsen, 1990). In contrast, PHC monitors plant health by focusing on prevention of plant problems through proper site analysis and plant selection before planting, proper planting procedures, and deliberate and proper maintenance activities (Ball, 1994; Lloyd and Miller, 1997). Although IPM and PHC differ in their approach to maintaining healthy landscape plants while protecting the environment, the overall concepts complement each other providing guidelines and recommendations for both homeowners and professionals.

The practices outlined by both IPM and PHC have been adopted by extension in an effort to educate professionals and consumers on the proper techniques for designing and managing their landscape (Dreistadt, 1994; Lloyd and Miller, 1997; Rajotte et al., 1987). The message is carried to both homeowners and commercial clientele through numerous forums including organized education programs, newspaper, television, and radio pieces, clientele phone calls, and question and answer venues at local and statewide events.

With extensive educational energies being employed to promote the practices and concepts of IPM and PHC through regional and state programming, such as the National IPM Network (Stinner, 2001) and extension publications like *Creating Healthy Landscapes* (Daniels et al., 1998) in Pennsylvania and similar publications in other states, the question arises, "How many consumers understand and are employing PHC and IPM practices in their own landscapes?" To address this question, an interactive computer survey was developed and employed at the 2001 Philadelphia Flower Show (PFS). The PFS was chosen as the survey site for three reasons: 1) the PFS represents the oldest and largest indoor flower and garden show in the world with an annual attendance of more than 300,000 people during its 8-d run (Pennsylvania Horticultural Society, 2002); 2) PFS attendees would provide a readily identified audience of gardeners; and 3) we hypothesized that PFS attendees would be more likely to employ practices such as IPM and PHC than the general population.

Materials and Methods

The site and participant recruitment constraints offered several limitations to standard surveying techniques including: large number of visitors at the display at one time, background noise and visual distractions, participants' short attention spans, and variability in participant age, experience and interest in gardening and the environment. A survey instrument was developed that would effectively, accurately, and interactively gather data on the practices employed by participants, measure participant knowledge of the concepts of IPM and PHC, and provide reinforcement and education. A computer-based touch-screen quiz format was employed that would allow participants to answer questions using multiple-choice options.

The survey consisted of 15 questions and was administered by Survey America and the TouchSource Group (Indianapolis, Ind.) on three touch-screen SurveyCenters. The computer automatically recorded survey results as participants touched answers on the screen. Data were collected continually from 4 through 11 Mar. 2001 while attendees viewed the show, resulting in 91 survey hours. This approach allowed participants to answer questions at their own pace.

The survey consisted of several parts including questions regarding PHC and IPM activities as well as demographic and sociographic characteristics. Four demographic questions included age, gender, home ownership, and location of residence. Three sociographic questions included interest in protecting the environment, interest in gardening, and use of professional landscape services. Participants were also asked to answer four multiple choice PHC questions of which three questions allowed multiple responses, with one of the questions having only one correct answer. The fourth PHC question required a single answer response. The questions focused on site selection, planting practices, reasons for mulching, and pruning. IPM questions were multiple-choice and required single-answer responses. Answers to the IPM questions were either 1) yes, no, or no opinion or 2) always, sometimes, never, or no opin-

ion. Questions focused on identifying, monitoring, and maintaining records of plant problems.

Results and Discussion

ATTRIBUTES OF THE PARTICIPANTS. Of the 2,158 consumers who participated in the study, a total of 728 usable responses were obtained after data were screened based on survey completion and participants meeting the minimum requirement of 19 years of age. Of those who qualified, the average age was 47 years. The greatest number of responses came from the 36 to 50 year-old age group (44%) followed by the 51 to 60 year-old age group (22%). Similar age-group response percentages have been reported for national gardening surveys with 47% of the responses from among consumers 35 to 54 years of age and 29% within the 55 years and over age group (Butterfield, 2002). A majority of the participants were Pennsylvania (55%) or New Jersey (21%) residents, owning and living in a single-family home (76%). Nationally, 80% of the gardening public lives in a single-family home with 85% ownership according to the American Nursery and Landscape Association (2000). Fifty six percent of the participants had never purchased professional services to help with their landscape, while 26% had on occasion purchased professional landscape services. Most participants were female (69%), were very interested in gardening (58%), and very interested in protecting the environment (77%). Slightly more females participated in the PFS survey than in national surveys (53%) (Butterfield, 2002). While Butterfield (2002) reports that 80% of the households surveyed were interested in gardening, just over half of the PFS participants were very interested in gardening. Overall the participants of this survey were similar in demographic characteristics to those reported in national surveys.

PHC KNOWLEDGE. The PHC survey questions were designed to allow participants to view multiple-choice answers and make decisions based on responses available. The intention was to determine the participants' knowledge level and identify topics where further education was needed. In the first question ("Which of the following features of your landscape are important to consider when choosing plants to purchase for your yard?"), the most correct response would have been to select all of the answers. Of the participants, 58% selected all five answers. The amount of sun or shade the area received was chosen most often (94%), followed by soil type and moisture holding capacity (85%), average temperature (74%), soil pH (74%), and exposure (70%). These results suggest that the participants have a strong knowledge of individual factors to consider in site analysis and plant selection; however, only 58% recognized the role of all of the factors in choosing the right plant for the right place.

In the second question ("select all of the following that you should do when planting a tree or shrub") multiple answers were accepted, but only one answer was correct. About half of the participants (49%) chose the correct answer (plant only as deep as the root ball or pot). The most common incorrect answers were "plant without disrupting the circular pattern of the roots in the pot" (40%) followed by "apply a mound of mulch 5 inches (12.7 cm) above the root ball" (39%), "dig the hole the same size as the root ball or pot" (27%), "all of the above" (25%), and "plant with pot, burlap, and/or twine remaining on the plant" (23%). Over half of the participants chose one or more incorrect answers to the question. Each of the incorrect answers indicated a misunderstanding of the planting process. The fact that over half of the participants chose incorrect answers suggests that the message on proper planting practices was not being completely understood.

The third PHC question asked participants to identify all of the reasons for applying 2 to 3 inches (5.1 to 7.6 cm) of mulch around their landscape planting. Multiple responses were allowed and less than half (49%) of the participants chose all five correct answers. The most popular answer was to reduce the amount of water evaporating from the soil (94%) followed by to reduce weed growth (91%). Nearly 77% of the participants thought that mulch protected their plants from maintenance practices such as mowing or that mulch provided a slow release nutrient source for the plants. Finally, 68% felt that mulch helped to keep plants looking well groomed. Overall, it appears that the participants recognized some of the benefits of mulching around plants.

The final PHC question requested participants to identify one factor that they consider most important in deciding when and how to prune. The most common response chosen was to improve and strengthen the structure and safety of the tree (47%) followed by removing damaged and diseased branches and enhancing blossom production (32%). The least prevalent responses included thinning to improve air circulation (4%), shearing into formal shapes (5%) and topping because the tree is getting too tall (5%). Of the participants, only 10% chose shearing and topping as key factors for decisions suggesting that most consumers are familiar with reasons that pruning is important.

IPM KNOWLEDGE. The IPM questions were designed to determine the use and proficiency of identifying pest problems and record keeping. A majority of the participants (71%) claimed to have identified insects on their plants prior to deciding on whether to treat the plants, while less than 17% reported that they did not identify the insects. Similarly, a majority (74%) claimed to regularly (approximately once a week or so) scout their landscape to determine the health of their landscape plants and the presence of pests. The first two questions represent keys to implementing IPM practices, proper identification and regularly scouting. Survey participants' responses suggest that these practices are being used. The third important concept in IPM is to keep track of the pests and insects found around plants and to keep record of past treatments applied. Of the participants only 21% always kept records, while an equal number never kept records, and about half (51%) kept records occasionally. Based on the responses to this question, it would appear that more emphasis should be placed on the benefits of record keeping when educating consumers about IPM.

The final IPM question addressed proficiency in identifying pest damage without seeing the pest. A majority of the participants (74%) reported identifying pest damage sometimes, while only 8% claimed that they were able to always identify pest damage without seeing the pest. Pest and damage identification activities are commonly employed during extension education programming for landscape professionals. Effectively doing the same for consumers is more difficult; however, web-based interactive modules may be an option for some pests.

IDENTIFYING CONSUMER KNOWLEDGE SEGMENTS. Examining the raw survey data can provide some insight into the participants' knowledge and can iden-

Table 1. Description of three consumer segments derived from cluster analysis based on participants' responses (%) to questions, including attitudes about landscape preparation and integrated pest management (IPM).

Variable	Consumer segment[z]			
	HS	PTG	HCl	Significance[y]
Number of observations (n)	498	184	46	
Percent of total respondents (%)	69	25	6	
Selected all the correct answers about what to consider when choosing landscape plant material for their yard.				
Correct answers	64	51	35	4*
Amount of sun or shade the area receives				
Soil type (clay, loamy or sandy) and drainage				
Soil pH				
Average minimum and maximum temperatures				
Site exposure to wind				
Select the only correct answer about what should be done when planting a tree or shrub				
Correct answer	59	50	17	1,3*
Plant only as deep as the root ball or pot				
Selected all the correct answers applying 2–3 inches (5.1–7.6 cm) of mulch around landscape plantings				
Correct answer	53	47	9	1,3*
Reduces weed growth				
Reduces water evaporation				
Releases nutrients				
Protects plants				
Keeps plants looking well				
Chose one of the following factors as being important when deciding when and how to prune				
To improve and strengthen the structure and safety of the tree	51	42	20	1,3*
Thinning will improve air circulation	5	2	2	1,2*
To remove damaged and diseased branches and enhance blossom production	29	34	50	1,3*
Identifies insect on plants before deciding how to treat them	92	23	35	4*
Regularly (about once a week or so) walks through their yard and landscape to check plant health and identify any pest problems	86	50	41	4*
Can identify pest damage without seeing the pest				4*
Always	9	4	4	
Sometimes	84	58	26	
Never	6	27	26	
No opinion	1	11	44	
Keeps track of pests and insects found on plants and how problems were treated in the past				4*
Always	29	2	9	
Sometimes	63	28	19	
Never	8	55	26	
No opinion	0	15	46	
Buys professional services to help care for their landscape				1,3*
Always	7	4	4	
Frequently	8	9	4	
Sometimes	29	21	11	
Never	55	63	35	
No opinion	1	3	46	
Interest in gardening				4*
Very interested	77	21	2	
Somewhat interested	22	65	2	
Not very interested	1	8	7	
Not interested at all	0	3	17	
No opinion	0	3	72	
Interest in protecting the environment				1,3*
Very interested	88	67	0	
Somewhat interested	12	31	4	
Not very interested	0	2	4	
Not interested at all	0	0	17	
No opinion	0	0	74	
Age 36 years and older	83	77	85	NS
Female	71	66	59	NS
Owns their residence	85	78	24	1,3*
Resident of Pennsylvania	55	64	20	2,3*

[z]HS = horticulturally savvy, PTG = part-time gardener, HC = horticultually challenged.
[y]1 = cluster 2 and 3 combined and tested against 1; 2 = cluster 1 and 3 combined and tested against 2; 3 = cluster 1 and 2 combined and tested against 3; 4 = all cluster comparisons are significantly different.
[NS,*]Nonsignificant or significantly different, respectively, at $P = 0.05$, based on a two-tailed t test and Kruskal-Wallis test.

tify general areas for future education. However, to better define groups of participants with similar understanding and use of PHC and IPM tools for future educational programming additional analysis was required. Cluster analysis (SPSS Inc., Chicago) was used to determine whether meaningful customer segmentations, based on participants' answers to several questions, could be created. Cluster analysis has been used by researchers to define consumer segments in regards to their preference for horticultural products such as edible flowers (Kelley et al., 2001) and geraniums (*Pelargonium ×hortorum*) (Behe et al., 1999) and perceived plant knowledge (Hardy et al., 1999). Variables used for clustering were based on the participants' responses to the PHC and IPM questions. Group responses can then be analyzed to determine how knowledgeable participants are about subject matter and help researchers and extension educators to focus on topics where gardeners' knowledge is deficient. By using K-Means (SPSS, Inc.), clusters of size 2, 3, and 4 were examined using 10 cluster algorithms. After examining each cluster size, the three-cluster solution was selected to develop customer-marketing segments.

Of the three distinct segmentations created, the largest group labeled horticulturally savvy accounted for 69% of the sample (Table 1.). Participants in this segment were more likely to correctly identify 1) important features to consider when choosing landscape plants (64%); 2) what should be done when planting a tree or shrub (59%); 3) all reasons for applying 2 to 3 inches of mulch in the landscape (53%); and 4) one of three factors to consider when deciding when and how to prune (85%).

Nearly half (47% to 51%) of the second largest group, labeled part-time gardeners (25% of the sample population), correctly answered questions about choosing landscape plant material, how to plant a tree or shrub, and why to apply 2 to 3 inches of mulch to the landscape. Fewer participants in this group answered these questions correctly compared to the horticulturally savvy.

The third segment of the survey population, the horticulturally challenged, accounted for 6% of the sample. Of the horticulturally challenged only 9% to 35% were able to correctly answer the questions. When additional answers were assessed, 78% of part-time gardeners and 72% of the horticulturally challenged correctly chose one of three factors to consider when deciding how to prune, as compared to 85% of the horticulturally savvy.

Of the three clusters, The horticulturally savvy was more likely to follow correct procedures when assessing plant health care and IPM options. At least 63% of the horticulturally savvy: 1) identify insects on plants before deciding how to treat them; 2) check plant health and pest problems in their yard on a regular basis; 3) sometimes identify pest damage when the pest is not present; and 4) sometimes record pests found on plants and treatments. In contrast, less than 58% of part-ime gardeners and 41% of horticulturally challenged identified insects before spraying, checked plant health and pest problems regularly, sometimes identified pest damage on plants without the pest present, and sometimes recorded pests and treatments.

Willingness of subjects to participate and make a conscious effort to conduct these activities may be related to their interest in gardening and in protecting the environment. It may be possible that as interest levels increase in these subjects, gardeners are more likely to implement IPM and PHC practices and follow advice from researchers, extension educators, garden writers, and other authorities. It was apparent that this may be true for our sample as the horticulturally savvy group showed a higher level of interest in gardening (77% were very interested) and protecting the environment (88% were very interested) compared to the part-time gardeners (21% and 67%, respectively) and the horticulturally challenged (2% and 0%, respectively). The horticulturally savvy group also was more willing to follow correct PHC and IPM procedures.

Demographic characteristics of the three groups were significantly different for residence ownership. More of the horticulturally savvy group (85%) owned their own residence compared to part-time gardeners (78%) and horticulturally challenged (24%). This may account for the greater percentage of horticulturally savvy who purchased professional services to help care for their landscape. With a greater number who own their residence, it could be implied that it is a more reasonable option for this group than for the horticulturally challenged, who were mostly renters. Among the respondents residing in Pennsylvania most (64%) were part-time gardeners, followed by the horticulturally savvy (55%), and horticulturally challenged (20%). This statistic suggests that the attendees of the PFS and participants in this survey represented a broad diversity of gardening backgrounds.

Conclusion

At least 47% of the horticulturally savvy and part-time gardeners were able to correctly answer PHC questions. They accounted for 44% of the total survey participants. These two segments also consisted of more individuals who were 1) very interested and 2) somewhat interested in gardening and protecting the environment as opposed to the horticulturally challenged who were more likely to not be interested in these topics or had no opinion. Research conducted by Hardy et al. (1999) revealed similar results. Participants with a greater perceived knowledge of home landscaping, outdoor tree and shrub care, and considered experts by their friends, preferred to work in their flower garden and yard to other study subjects (Hardy et al., 1999).

It is apparent that most gardeners were represented in the horticulturally savvy and part-time gardener groups which therefore had higher percentages of individuals who correctly answered questions and were more willing to participate in IPM and PHC practices. In some capacity, whether it is print media, television, or one-on-one advice, gardeners are learning and following instructions on topics currently discussed at universities and garden centers. Though not all gardeners are well versed in all subject matter, a basic knowledge of PHC and IPM are the foundation of a healthy landscape and rewarding experience.

Overall survey results suggest that site selection criteria, planting practices, mulching practices, and keeping track of pests and treatment applications remain important and misunderstood practices for most participants. These suggestions were reinforced by results from cluster analysis which defined consumer segments. As extension educators, we need to evaluate our educational programming to address the misunderstanding in IPM and PHC concepts identified here, recognize that the audiences we address have mixed interests and knowledge levels and design programming

with that in mind, and accept that not all audiences are interested in furthering their knowledge level as demonstrated by the "Horticulturally Challenged" segment of our participants. Programming that is created for consumers or other audiences should be reviewed by these segments to ensure that the information is easy to understand and in a form that will be accessed by these targeted individuals; thus, insuring that they will be equipped to have a successful and rewarding gardening experience.

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