ARIZONA COOPERATIVE EXTENSION
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Arizona golf course pesticide use survey

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Introduction/objectives

Arizona's golf course industry has grown rapidly over the last fifteen years, and it is likely to continue to grow in response to increasing numbers of winter visitors and of retirees who choose to live here throughout the year. As more people use Arizona's golf courses, and more golf courses are built, concern about pesticide use on these courses increases.

This survey was initiated to provide the golf course industry, the pesticide industry, and the public with much-needed baseline data. Specifically, it was conducted (1) to identify major and minor pests on golf course turf, and to assess the damage being done by these pests; (2) to estimate the types and amounts of pesticides being used on golf courses; (3) to determine whether or not golf courses use integrated pest management (IPM) and best management practices (BMP's); and (4) to verify safety and environmental practices used on golf courses (i.e., safety training, use of personal protective equipment, proper disposal of pesticides and pesticide residues).

Materials and methods

Developed in cooperation with the University of Arizona Karsten Turfgrass Facility and the Arizona Cactus and Pine Golf Course Superintendents Association, the survey was designed to cover four main topic areas: (1) general golf course information (i.e., type, size); (2) golf course pests; (3) pesticide use; and (4) management practices.

Although the survey questionnaire (see Appendix) comprised thirteen pages, with some quite involved questions, the information requested was based on available knowledge, and most of the information should have been relatively easy for superintendents to furnish, provided they were current with standard recordkeeping. Estimated average time to complete the survey questionnaire was 20-40 minutes.

A list of Arizona golf course superintendents was obtained from the Arizona Cactus and Pine Golf Course Superintendents Association, whose membership includes 75 to 80% of all superintendents within the state. In January 1995, an introductory letter and the survey were mailed to all 175 of the association's superintendent members requesting 1994 data. Enclosed with the survey questionnaire was a self-addressed, stamped, return envelope. Three weeks after the questionnaires were mailed out, a reminder letter was sent to members who had not responded; three weeks after that, we started our analysis.

Analysis tools

The survey was separated into (1) a turf management/facilities section, and (2) a pesticide use section. The turf management/facilities section was encoded into Questionnaire Programming Language (QPL),a basic shareware data management program developed by Kevin Dooley in the U.S. General Accounting Office and designed to automate much of the gathering and analyzing of questionnaire data. The more complicated pesticide use section was processed using Excel, a Microsoft software product that provided greater flexibility than QPL in analyzing data.

Simple descriptive statistics were used for most of the survey data. Rank orders and means were sufficient for all questions except Question 14 (pesticides used), which required more specific analysis.

Results and discussion

To summarize our results, we arranged them into four categories: (1) general questions; (2) pests; (3) pesticides; and (4) management.

General questions *(Questions 1-4)*

Of the 175 survey questionnaires mailed out, 48 were returned, for a 26.9% return rate. One blank questionnaire was returned with a short note explaining that the respondent had retired. Thus we had 47 usable questionnaires to analyze. Under general course information, 85% of the golf courses surveyed were regulation courses; 81% were 18-hole courses; 66% were either Daily Fee or Private, and nearly 20% were semi-private. Maricopa County was by far the largest participant, with 57% of the respondents; 11% were from Pima County; 6% from Coconino County, 4% each from Pinal and Navajo Counties; and 2% each from Cochise and Yavapai Counties. Six survey questionnaires (13%) were returned with no county designated.

Course acreages and turf types are reported in Table 1. Of the 47 survey respondents, 40 (85%) indicated they maintained primarily warm-season turf, whereas 44 (94%) indicated they had cool-season turf. This high percentage of cool-season turf was expected because courses at higher elevations use only cool-season turf and because it is standard practice at lower elevations to overseed bermudagrass tees and greens and/or fairways with cool-season grass turf. On tees, greens, and fairways, the total acreage for warm- and cool-season turf was almost equal. In roughs and landscaped areas, however, total acreage for warm-season turf was two to three times larger than

for cool-season turf. This is most likely due to the selective overseeding of fairways and approaches versus wall-to-wall overseeding of the course itself; landscaped areas between roughs may or may not be irrigated, depending on the course design, location, and age of the course.

Pests
(Question 15)

Respondents were asked to rank pests on a scale of 1 to 5, with 1 signifying minor pests and 5 signifying major pests. For example, 8 superintendents ranked rove beetles as a 1 (minor pest); 1 superintendent ranked them as a 2; 11 ranked them as a 3 (average pest); 4 as a 4; and 3 as a 5 (major pest). The rankings were weighted (i.e., 8 x 1 = 8; 1 x 2 = 2; 11 x 3 = 33; 4 x 4 = 16; 3 x 5 = 15), added together (i.e., 8 + 2 + 33 + 16 + 15 = 74), and then divided by number of respondents actually reporting (8 + 1 + 11 + 4 + 3 = 27) to get an overall weighted average ranking (2.74). This ranking system allowed us to determine which pests were considered to be the most damaging.

Table 2 lists pest rankings in order of the most damaging pest in each category (insects, diseases, weeds, miscellaneous) to the least damaging. Column 4 indicates the area on the golf course where the pests were reportedly causing the most damage. The numbers in parentheses after a given area, for example, greens (9), indicate the number of respondents who reported this as the area where the pest is the problem.

In the insect category in Table 2, the top three pests were rove beetles, cutworms, and white grubs. Cutworms and white grubs are problems nationwide, but rove beetles are beneficial in many settings. Unfortunately, in Arizona, they excavate soil to the surface of the greens and tees, creating problems for golfers and fine turf-mowing equipment. Of the diseases reported, fairy ring was the number one problem, followed by brown patch and pythium blight. Very few respondents reported plant diseases as a major problem. Annual bluegrass was by far the greatest weed problem. This was followed by unwanted bermudagrass, nutsedge, and crabgrass/cupgrass. According to our rating system of weighted averages, weeds were the greatest problem faced by superintendents. In the miscellaneous category, rodents, rabbits, and ground squirrels were the top three pests and were described as being everywhere on the golf course. In summary, the overall rankings for pest problems were, from greatest to smallest order, weeds, insects, diseases, and miscellaneous.

Pesticide-Related Issues

Environmental/human risks
(Questions 5-8)

Of the 47 respondents, 94% (44) indicated they had no problems with drift of pesticides either on or off the course. Of the remaining 6%, all but one complaint indicated the problem was associated with off-site pesticide movement in soil. We asked the respondents to indicate what undesirable effects were observed or reported from pesticides, and their responses are reported in Table 3. As indicated in the table, there were 14 positive ("yes") responses (Yes Complaints) out of a total of 329 responses, signifying a very low complaint response rate. This does not mean that the low numbers of complaints from workers, golfers, or neighbors and homeowners do not need to be addressed, but suggests rather that superin-

Table 1. Course Acreage and Turf Type

Warm-Season turf	Total acreage	Average acreage	Cool-Season turf	Total acreage	Average acreage
Tees	130	3.3	**Tees**	167	3.8
Greens	105	2.6	**Greens**	141.2	3.2
Fairways	1,539	38.5	**Fairways**	1,414	32.1
Roughs	2,079	52	**Roughs**	895	20.3
Landscaped areas	377	9.4	**Landscaped areas**	69.8	1.6

tendents are aware of the problems and are attempting to keep them to a minimum.

When we asked superintendents whether they notified golfers before, as or after pesticides were applied, 51% of respondents indicated they did, while 49% indicated they did not notify golfers when pesticides were used. Of the 51% who did notify golfers of pesticide use, 47% put up postings in the clubhouse, and 42% had postings on the course; the remaining 11% notified the golfers by some other means such as word of mouth, reports via the pro shop, or notices in a monthly newsletter. It is unknown whether these notifications identified the pesticide or its signal class, or whether any other type of information was given.

All respondents indicated there had been no accidents in which pesticides were released into the environment within the previous twelve months.

Pesticide storage and disposal *(Questions 9-13)*

With 47 respondents reporting, pesticide concentrates were disposed of on-site by 35% of the respondents; returned to the supplier or manufacturer by 21%; and disposed of via a private contractor by 10%; while 4% exchanged pesticide concentrates with other users. A surprising 30% of the respondents either did not respond to this question or marked "other" on the survey, supplying answers that were difficult to categorize.

Table 2. Pests Associated with Golf Courses

INSECTS	Ranking Minor Problem. . . . . Major Problem 1	2	3	4	5	Weighted average ranking	Areas of major pest problems (4s and 5s)
Rove beetle	8	1	11	4	3	2.74	Greens (7), tees (2)
Cutworms	9	7	11	9	0	2.56	Greens (9)
White grubs	13	5	7	2	3	2.23	Greens (3), roughs (2), fairways (2)
Ants	12	9	10	2	0	2.06	Sand traps, tees, roughs
Chinch bugs	15	4	4	1	0	1.63	Greens
Sod webworms	13	9	1	0	1	1.63	Greens
Aetenius beetle	13	3	3	1	0	1.60	Aprons
Billbugs	13	6	0	1	0	1.45	Tees
Ground pearl scale	11	3	1	0	0	1.33	
Bermudagrass stunt mites	15	0	1	0	0	1.13	
Frit flies	14	3	0	0	0	1.18	
Nematodes	13	1	0	0	0	1.07	
Leafhoppers	16	1	0	0	0	1.06	
DISEASES	**Ranking Minor Problem. . . . . Major Problem 1**	**2**	**3**	**4**	**5**	**Weighted average ranking**	**Areas of major pest problems (4s and 5s)**
Fairy ring	8	1	11	4	3	2.74	Greens (7), tees (2)
Brown patch	9	7	11	9	0	2.56	Greens (9)
Pythium blight	13	5	7	2	3	2.23	Greens (3), roughs (2), fairways (2)
Dollar spot	12	9	10	2	0	2.06	Sand traps, tees, roughs
Leaf spot	15	4	4	1	0	1.63	Greens
Other ring or patch diseases	13	9	1	0	1	1.63	Greens (2), tees

WEEDS	Ranking Minor problem. . . . . Major problem 1	2	3	4	5	Weighted average rankng	Areas of major pest problems (4s and 5s)
Annual bluegrass	4	6	7	10	11	3.47	Roughs (8), greens (14), fairways (8), tees (5), landscape (1)
Bermudagrass (unwanted)	4	9	7	9	2	2.87	Greens (5), roughs (2), bunkers (1), landscape (3)
Nutsedge	5	10	11	2	2	2.53	Roughs (3), tees (2), green banks, tee banks
Crabgrass/cupgrass	6	14	7	5	2	2.50	Greens (3), tees (2), fairways (5), roughs (3)
Russian thistle	12	5	4	4	3	2.32	Roughs, secondary roughs, washes, native areas, perimeter areas, landscape
Clovers	11	7	8	4	1	2.26	Fairways (3), tees (1), roughs (1)
Mustards (i.e.yellow rocket)	10	10	3	5	2	2.3	Roughs (4), landscape (2), washes
Goosegrass	10	8	5	2	2	2.19	Greens (2), tees (1), roughs (2), fairways (2)
Other summer annual grasses	7	6	7	2	0	2.18	Landscape, fairways, roughs
Spurge	10	13	9	2	0	2.09	Landscape, tees, fairways
Khakiweed	11	5	1	3	0	1.8	Roughs (3)
MISCELLANEOUS	**Ranking Minor Problem. . . . . Major Problem 1**	**2**	**3**	**4**	**5**	**Weighted average ranking**	**Areas of major pest problems (4s and 5s)**
Rodents	12	3	4	6	2	2.37	Tees, roughs (3), fairways (3), everywhere
Rabbits	8	7	3	4	1	2.26	Tees (2), roughs (2), greens, fairways (2), banks, flowers
Ground squirrels	10	6	5	1	2	2.13	Roughs, everywhere
Birds (including ducks and geese)	14	3	2	2	2	1.91	Greens (3), fairways (2), driving range tees

The most common (used by 88% of respondents) method for disposal of empty pesticide containers was triple rinsing followed by standard disposal. Often containers were cut up or punctured prior to disposal; 8% of the respondents recycled the container with a vendor; and 2% each used a private contractor or disposed of the container on-site. Two or more of the above methods were practiced by13% of the respondents; one respondent provided no answer in this area.

Excess spray mix and rinse water were disposed of according to label directions by 87% of the survey respondents; 13% percent indicated that they disposed of the excess on-site, while none used a private contractor.

Again, with 47 respondents reporting, 94% of the respondents stored their pesticides in a locked storage area; 30% stored their pesticide in an area separate from fertilizer and equipment; 19% indicated that they stored their pesticides in a locked storage area that was also separate from fertilizer and equipment. Asked whether their storage areas were fenced, 77% reported they were, while 23% said the ares were not fenced. However, it is unclear whether fenced storage areas were fenced separate from or together with maintenance compounds. Likewise, for storage areas not fenced, it is unclear whether the maintenance compounds or the pesticide storage areas themselves were not fenced.

Pesticide Training and Safety
(Questions 16-20)

Of the 47 respondents, 98% (46) of them reported that they were certified applicators; 89% (42) indicated that they employed pesticide applicators who were certified; and 81% (38) provided pesticide training programs for applicators, although it was not determined whether training was in-house, commercial, by consultant, or through Cooperative Extension. Overall, training was provided an average of 3.4 times per year, although once a year was the most common interval for training received (see Figure 1).

Washing or shower facilities for applicators were provided by only 79% (37) of the respondents.

Pesticide Use
(Question 14)

The pesticides reported used were separated into classes: insecticides, preemergent herbicides, postemergent herbicides, growth regulators, and fungicides. Respondents were asked to provide the amount of each pesticide brand used, based on location (greens, tees, etc.), the number of times the product was used, the number of acres to which pesticide was applied, and how effective the product was on a scale of 1 to 4, with 4 being the most effective for control. The results are presented in Table 4. The pesticides are in order by weight, that is, the pesticides most used by total pounds of A.I. are listed first in each of the sections of the table. Also presented are the total number of brand names used that contain the active ingredient, average number of times the products were applied, total acres treated, and the average rate of effectiveness of each active ingredient.

In general, herbicides (pre- and postemergent, combined) were by far the largest category of pesticide reported used, at 13,022.97 pounds A.I. out of an overall

Table 3. Environmental/Human Risks Reported on Arizona Golf Courses

COMPLAINTS	YES	NO	TOTAL
Workers	1	46	47
Golfers	5	42	47
Plants (phytotoxicity)	4	43	47
Aquatic organisms	0	47	47
Other nontarget organisms	1	46	47
Neighbors, homeowners	3	44	47
Other	0	47	47
TOTAL	14		

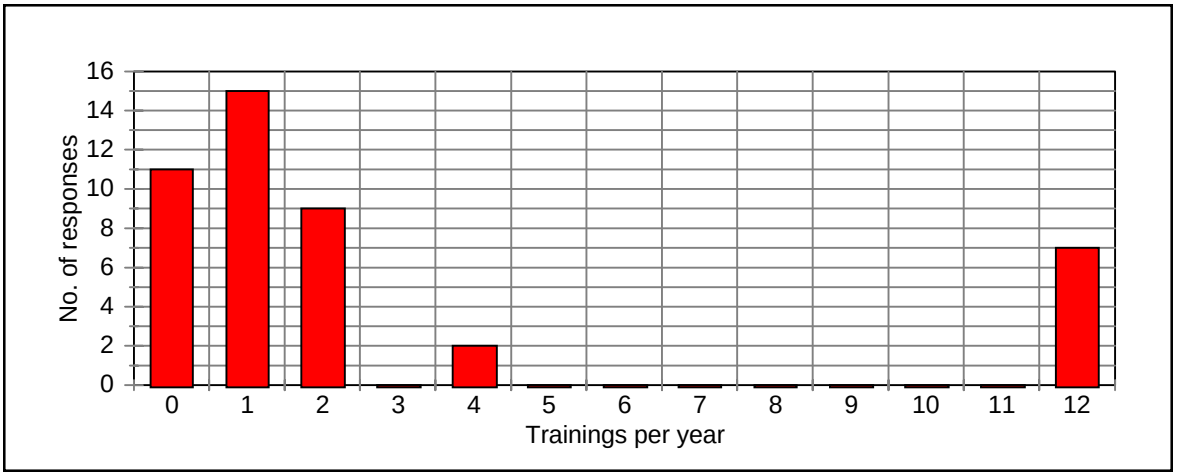

Figure 1. Frequency of Trainings per Year

total of 15,548.57 pounds A.I., or 83.8%. Insecticides reported at 1,482.08 lbs A.I. overall, represented 9.5% of the total pesticide use; followed by fungicides at 1,028.76 lbs A.I., or 6.6%; and growth regulators, at less than 1%. Ranked by category from most to least used are preemergent herbicides (9,424 lbs A.I.), postemergent herbicides (3,598 lbs A.I.), insecticides (1,482 lbs A.I.), fungicides (1,028 lbs A.I.), and growth regulators (14 lbs A.I.). The preemergent herbicides bensulide, oryzalin, and prodiamine together make up 50% of all materials reported used. Glyphosate use constituted an additional 7.4% of the total. The top ranking for herbicides reflects the top ranking of weeds among pest problems; and the nature of weed problems based on the biology and competitiveness of annual and perennial weeds in year-round turf situations.

The insecticides carbaryl, fonofos and dimethyl made up 85% of the insecticides reported used on golf courses in 1994. This is understandable because the three major insect problems (rove beetles, cutworms, and white grubs) can be controlled with these three materials. Not surprisingly, carbaryl was the insecticide most used, due in part to its broad label applications. Fungicides are not heavily used in Arizona due to the dry environment; the use of growth regulators was very limited.

Management

Best Management Practices (BMP) *(Question 21)*

Forty-four of the 47 (94%) respondents indicated that they used best management practices (BMPs). The other three respondents were not sure whether or not they used BMPs, but indicated they practiced some of the items in the list of BMPs provided. Therefore, we assume 100% of the respondents used at least one best management practice. As for which best management practices were used, see Table 5.

Integrated Pest Management (IPM) *(Questions 22, 23)*

Thirty-seven of the 47 respondents (79%) indicated that they used integrated pest management (IPM) on their courses; 2 indicated that they were not sure whether they used IPM, but indicated they used some of the IPM practices listed. Thus a total of 39 respondents (83%) actually used IPM on their courses. IPM practices are presented in the Table 6 from highest use to lowest use.

Although it was expected that all superintendents would report that they were using IPM, only 39 (83%) indicated they did so. This was made even more surprising by the fact that 100% of them indicated they used BMPs. IPM practices have been in existence much longer than have BMP s, although it seems that BMPs are more widely used on golf courses than are IPM practices. Twenty-three respondents (49%) indicated that they had achieved some pesticide use reduction with IPM practices, the average amount being 36%. Whether or not there was an actual reduction in pesticide use was not verified, but the perception was that IPM did help to reduce the average amount of pesticide used.

Water Use *(Questions 24 27, 30, 31)*

The total amount of water in acre feet (AF) used averaged 452.44 for the 26 respondents answering this question. The average percentage of water used in each season is listed in Table 7.

Overall, respondents reported using 86% potable or

well water, versus 14% effluent, for irrigation water on these golf courses. Of the 45 superintendents answering Question 27, 34 (76%) used 100% potable or well water; only 2 respondents (4%) used more effluent than potable water. Golf course roughs were irrigated the least frequently, compared to all other areas. Fairways, tees, and greens had equal priority in terms of irrigation frequency. Irrigation frequency was highest in summer, followed by spring, fall, and winter; and was nearly identical in spring and fall (see Table 8).

Most courses irrigated during the evening or night hours to decrease evaporation (see Table 9). Morning irrigation may have been confused with night irrigation; there is obvious overlap between morning and night irrigation, as many of the irrigation systems start at dark and finish by 5:00 a.m. Moreover, day in winter irrigations may have actually been morning irrigations to melt frost in order to speed up morning play. Multiple or unclear designations for irrigation time may thus subject our results to differing interpretations as well.

Fertilization
(Questions 28, 29)

As expected, the greens were fertilized, on average, nearly twice as often as were tees, the next most often fertilized areas: 17.7 times per year versus 9.5 times. Fairways were fertilized, on average, only 7 times per year, and roughs only 4.6 times.

Foliar applications of fertilizer were practiced to a large extent on greens (83%) and tees (62%), but to a lesser extent on fairways (45%) and roughs (19%; see Table 10). All areas received high percentages of granular formulations of fertilizers (greens: 98%; fairways: 94%; tees: 94%; and roughs: 81%). Fertigation was practiced almost evenly across all turf areas on the golf course greens: 38%; tees: 36%; fairways: 30%; and roughs: 28%. This is most likely a function of systems installation, with area selection the second factor for fertigation use.

Summary

The final survey return rate was 26.9% (47 out of 175 total survey questionnaires mailed). Most of the survey respondents represented 18-hole, regulation, daily fee, or private golf courses; 57% of the survey questionnaires returned were from superintendents located in Maricopa county.

The major insect pests reported were rove beetles, cutworms, and white grubs. Annual bluegrass was by far the worst weed pest, while fairy ring and brown patch were the two worst disease problems reported. Rodents were also reported to be a sizable problem.
Forty-four (94%) of the respondents indicated no problems with pesticide drift and few complaints were received by the superintendents regarding pesticides. The few com-

Table 4. Golf Course Pesticide Use

HERBICIDES, PREEMERGENT	Number of brand names used	Total pounds used (A.I.)	Average number of times applied	Total number of acres treated	Average rate of effectiveness (1-4)
Bensulide	4	3974.7	1.8	148.5	2.7
Oryzalin	2	2827.6	1.6	791.3	2.9
Prodiamine	2	1037.8	1.7	877	3.2
Pendimethalin	4	466.4	1.3	206.4	3.0
Simazine	2	379.7	1.3	193.0	2.8
Fenarimol	2	378.9	1.9	214.4	3.0
Dithiopyr	1	210.5	1.0	398.0	3.2
Benefin	1	113.0	1.0	145.0	2.8
Isoxaben	1	31.5	1.0	42.0	3.3
Oxadiazon	2	4.8	1	7.8	2.8
TOTAL		9,424.9			

HERBICIDES, POSTEMERGENT	Number of brand names used	Total pounds used (A.I.)	Average number of times applied	Total number of acres treated	Average rate of effectiveness (1-4)
Glyphosate	2	1148.5	3.7	529.2	3.4
2, 4-D products	8	600.2	2.1	603.6	3.1
MSMA	5	564.8	2.3	225.5	2.8
Ethofumesate	1	405.2	1.6	222.3	2.9
Mecoprop	5	350.1	1.9	467.2	3.1
Copper	2	240.6	4.3	56.5	2.7
Diquat Dibromide	1	222.4	2.7	123.5	3.4
MCPP	2	19.5	3.0	26.4	3.0
Dicamba	5	19.1	2.4	215.0	3.1
Glufosinate ammonium	1	15.1	2.0	25.1	3.3
Imazaquin	1	6.0	1.0	0.1	not given
Triclopyr	1	5.2	1	5.0	3.0
Fluazifop-P-butyl	1	1.5	1.5	4.8	3.0
TOTAL		3,598.1			
INSECTICIDES	**Number of brand names used**	**Total pounds used (A.I.)**	**Average number of times applied**	**Total number of acres treated**	**Average rate of effectiveness (1-4)**
Cabaryl	1	563.4	2.8	77.6	2.7
Fonofos	1	480.8	1.6	125.2	3.2
Dimethyl	2	219.3	1	7	2.5
Chlorpyrifos	5	156.5	1.7	56.3	3.2
Isophenfos	3	31.7	1.6	12.5	3.1
Bendiocarb	2	27.6	1.8	22.7	2.9
Imidacloprid	1	2.8	1	45.3	2.5
TOTAL		1,482.1			

FUNGICIDE	Number of brand names used	Total pounds used (A.I.)	Average number of times applied	Total number of acres treated	Average rate of effectiveness (1-4)
Chlorothalonil	1	397.4	1.8	32.8	3.2
Mancozeb	4	295.6	2.6	47.6	3.6
Aluminum tris	2	75.2	2	9.8	3
Chloroneb	1	74.1	2	11.5	3.3
Thiophanate-methyl	2	72.4	1	9.3	3
Flutolanil	1	54	2	6.6	3.5
Metalaxyl	4	37.1	1.4	30.4	3.2
Iprodione	2	16.1	1.3	10.6	3.3
Triadimefon	2	4.2	2	1	3
Anilazine	1	2.5	1	2.7	3
Sulfur	1	0.2	2	0.1	not given
TOTAL		1028.8			
GROWTH REGULATORS	**Number of brand names used**	**Total pounds used (A.I.)**	**Average number of times applied**	**Total number of acres treated**	**Average rate of effectiveness (1-4)**
Trinexapac-ethyl	1	14.5	1.6	412.5	3.1
Flurprimidol	1	0.1	2	0.1	3
Mefluidide	1	0.1	1	1	not given
TOTAL		14.8			

plaints received were from golfers and neighbors or homeowners; there were also a few instances of undesired effects of pesticide on nontarget plants. Only half (51%) of the golf courses had some method of notifying golfers when pesticides would be or had been used.

Over one-third (34%) of the superintendents disposed of their excess pesticide concentrates on-site. Pesticide containers were most often triple rinsed (88%) and put in the trash. Excess spray mix and rinse water were used up according to label directions 87% of the time. Nearly all of the respondents (93%) stored their pesticides in a locked storage area and almost one-third (30%) stored their pesticides in an area separate from fertilizer and equipment.

A total of 15,548.57 pounds of pesticide active ingredient was applied to the responding golf courses. Herbicides made up the bulk of this total (83%), while insecticides represented 9.5%; followed by fungicides at 6.6%, and growth regulators at less than 1%. The preemergent herbicides bensulide, oryzalin, and prodiamine together made up 50% of all materials used. The insecticides carbaryl, fonofos, and dimethyl made up 85% of the insecticides reported used on the golf courses. Of the responding superintendents, 98% were certified applicators, while 89% indicated they employed pesticide applicators who were certified; 81% provided pesticide training programs for applicators.

Two surprising results revealed by this survey are: (1) 100% of the respondents (47) indicated they used best management practices (BMPs), whereas only 79% (37) indicated they used Integrated pest management (IPM), perhaps due to terminology interpretations; and (2) 72% of the respondents (34) indicated they used 100% potable water to irrigate their golf courses, whereas only 4% of the respondents indicated they used more effluent than

Table 5. Best Management Practices on Golf Courses

BMP	Total number of times BMP checked off in survey	% of respondents using this BMP
Proper aerification	44	94
Topdressing	44	94
Return clippings to fairways and rough	40	85
Foliar fertilizers spoon feeding	36	76
Thatch removal	35	74
Minimal watering	32	68
Lightweight mowers	30	64
Slow release fertilizer	27	57
Minimal fertilization	25	53
Deep watering	19	40
Slow release/fast release fertilizer	18	38
Higher mowing heights	14	30
Soil temperature monitoring	14	30
Do not overseed (saves water)	12	26
Other	1	2
Commercial software for disease/pest forecasting	0	0

potable water. There is a need to continue to track the data reported in this survey, and it is hoped that funding and resources will be available to survey Arizona's golf courses at least once every five years.

Table 6. Integrated Pest Management Practices on Golf Courses

IPM Practice	Total number of times IPM practice checked off in survey	% of respondents using this IPM practice
Scouting	28	24
Higher tolerance levels of pests	22	19
Drought tolerant species	16	14
Endophyte containing grasses (at overseeding)	16	14
Biological controls	15	13
Traps	15	13
Other	3	3
Commercial software for disease/pest forecasting	0	0

Table 7. Average Percent of Water Used per Season per Golf Course

Spring	27
Summer	44
Fall	16
Winter	10

Table 8. Average Per Week Irrigation Frequency by Season

	Greens	**Fairways**	**Tees**	**Rough**
Spring	4.9	4.4	4.7	3.7
Summer	7	6.2	6.3	5.3
Fall	4.5	4.3	4.6	3.3
Winter	2.6	2.1	2.5	1.3

Table 9. Irrigation Schedule by Time of Day and Season

SPRING					SUMMER				
	Greens	Fairways	Tees	Roughs		Greens	Fairways	Tees	Roughs
Morning	9	1	6	2	**Morning**	8	1	5	2
Day	1	1	1	1	**Day**	0	0	0	0
Evening	11	11	10	8	**Evening**	10	11	10	8
Night	26	34	30	33	**Night**	29	35	32	34
FALL					**WINTER**				
	Greens	Fairways	Tees	Roughs		Greens	Fairways	Tees	Roughs
Morning	10	2	7	3	**Morning**	7	1	4	2
Day	2	1	1	1	**Day**	3	2	1	2
Evening	10	11	9	8	**Evening**	9	10	9	8
Night	25	33	30	32	**Night**	24	25	27	22

Table 10. Types of Fertilizer Application

	Greens		Fairways		Tees		Roughs	
	Yes	No	Yes	No	Yes	No	Yes	No
Foliar	39	8	21	26	29	18	9	38
Granular	46	1	44	3	44	3	38	9
Fertigation	18	29	14	33	17	30	13	34