Extension Education Methods

Master Gardener's Confidence and Use of Integrated Pest Management

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Summary. The North Central Consumer Horticulture Working Group developed and distributed a 14-question survey to determine the confidence of north-central U.S. extension Master Gardeners (MGs) in making integrated pest management (IPM) recommendations and their use of IPM. The online survey was completed by 3842 MGs in Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. MGs indicated they personally engaged in a range of IPM practices, including prevention, monitoring, cultural, and chemical controls. However, 81% indicated a need for more training in identifying diseases, and 65% say they needed more training in identifying insects. Only 16% indicated they had received advanced pest management training within the past 5 years. These MGs had higher mean scores for confidence, as well as prevention, monitoring, and cultural control and chemical awareness/control practices than those not participating in advanced training. Years of experience as an active MG and confidence in using IPM-related garden activities were correlated positively (r = 0.261). MGs with advanced pest management training were more confident in making IPM recommendations to other gardeners and were much more likely to use IPM practices than MG without advanced training.

Extension Master Gardeners (MGs) have been trained for nearly 40 years by land grant universities as paraprofessionals to give gardening advice and pesticide recommendations to the public (Meyer, 2007). Extensive time and money is devoted to teaching MGs (Meyer and Hanchek, 1997). MGs are encouraged to use integrated pest management (IPM) in their own gardening practices and in their educational outreach work. IPM is "a long-standing, science-based, decision-making process that identifies and reduces risks from pests and pest management related strategies. It coordinates the use of pest biology, environmental information, and available technology to prevent unacceptable levels of pest damage by the most economical means, while posing the least possible risk to people, property, resources, and the environment" (North Central IPM Center, 2010).

Two barriers to using IPM have been identified as consumer's preference for a perfect lawn and a lack of awareness about plant ecology (Ingram et al., 2008). Although much has been written about MG training (Meyer, 2007), assessing MG confidence in their volunteer work is limited (Swackhamer and Kiernan, 2005). MGs readily adopt new practices (Peronto and Murphy, 2009) and are interested in lowering pesticide use (Sadof et al., 2004). Ohio MGs were found to practice 80% or more of the IPM techniques listed in a 2006 survey (Kohli, 2006). Additionally, these MGs had high IPM knowledge levels and were most interested in obtaining more information regarding disease-resistant plants and identifying insects and their damage (Kohli, 2006).

To further understand how to advance the application of IPM, a survey was developed by the North Central Consumer Horticulture Working Group to determine MGs confidence level in making IPM recommendations and their own use of IPM.

Materials and methods

A non-probability sampling approach was employed to gather data from MGs in 11 north-central U.S. states. State MG coordinators used direct e-mail notification and announcements through websites and electronic newsletters to invite MGs to complete a 14-question survey relating to their confidence in making IPM recommendations and their use of IPM through SurveyMonkey software (SurveyMonkey, Portland, OR). The survey was available for a 6-week period from mid-April to late-May 2009.

An exploratory, multi-item approach was used to estimate confidence and engagement in IPM-related practices. Given the extant research and theory, IPM components were defined as prevention, monitoring, cultural control, and chemical awareness/control. MGs responded to the full set of questions on IPM practices for each of five kinds of plants: fruit, vegetables, flowers, trees, and lawns. As a result, data were explored to examine the fit of measurement models

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presuming that IPM practices are spread consistently across plant types, and for testing research questions about how experience and advanced training relate to these IPM practices among MGs.

Cronbach's alpha was employed to examine the internal consistency of these models. Alpha based on standardized items did not differ appreciably for any estimate, indicating that no variance assumptions were violated within the items, and is therefore not reported. Training analysis and group sample differences were compared. Given the large difference in group sizes across our advanced trained and no advanced trained groups, careful attention was paid to these assumptions. All distributions were roughly normal, regardless of comparison group. However, several times, Levene's test for homogeneity of variance assumption indicated that group variances were not equal. One remedy for this problem is to use a weighted means approach, or least squares computation (Harris, 1994). This computation was employed in all cases, using standard analysis of variance procedures in SPSS (version 17; SPSS, Chicago).

Table 1. North-central U.S. Master Gardener (MG) state affiliation and advanced pest management training in the past 5 years.

State	Responses [no. (total MGs)]	Advanced training (no. responses)	No advanced training (no. responses)[z]
Illinois	623 (3,600)	65	558
Indiana	189 (3,600)	52	137
Kansas	178 (900)	68	110
Michigan	987 (4,600)	152	835
Minnesota	228 (2,200)	48	180
Missouri	465 (2,500)	74	391
Nebraska	104 (587)	22	82
North Dakota	34 (600)	0	34
Ohio	342 (1,860)	51	291
South Dakota	155 (450)	7	148
Wisconsin	522 (2,019)	50	472
Total	3,842 (22,916)	589	3,238

[z]Total training response number may be lower than state responses due to some participant's failure to include state data.

Table 2. Integrated pest management (IPM) use by Master Gardeners in the north-central U.S. Participants were instructed to control which of the following pest management practices they typically used for each of five plant types: trees and shrubs, fruit, vegetables, lawns, and flowers. Each positive response was tallied and combined for the five plant types, thus, the four preventative practices across five plant types could result in a total maximum response of 20; three monitoring practices across five plants would yield a maximum of 15 responses; etc. The Cronbach's alpha, mean, and SD are shown for each of the four practice categories.

IPM practice	Participant usage (%)	Alpha	Mean	SD	Range of possible responses
Preventive		0.77	8.26	3.86	0–20
Choose varieties that are pest resistant	87				
Choose planting dates to avoid pests or diseases	59				
Remove poorly adapted, exotic, or invasive plants from my yard	89				
Keep plants stress free by providing optimal growing conditions and maintenance	94				
Monitoring		0.79	6.20	3.19	0–15
Routinely inspect plants for insect pests or diseases	97				
Keep records of pests and management practices I have used in my yard or garden	25				
Accurately identify pest or disease before taking action	88				
Cultural control		0.85	14.30	6.05	0–40
Hand-pull or mechanically remove weeds	99				
Hand-pick then destroy pests or diseased plant parts	88				
Clean up plant residue in fall	87				
Plant border rows of flowers to attract beneficial insects	56				
Mulch plants with organic or synthetic materials	91				
Manage irrigation water to keep leaves dry	61				
Rotate plants within the garden	68				
Cover young plants with screen or row-cover fabric to block pests	25				
Chemical control		0.83	4.90	3.01	0–10
Consider all available pest control options before using pesticides (synthetic, natural, organic, and/or biological)	77				
Read and follow all instructions on pesticide label	83				
(I) Do not use chemical pesticides	50				

Slightly uneven sample totals appear within some of the analyses using these variables due in part to the fact that some respondents simply did not grow some of the plants we were asking them to consider. Our survey design, however, did not include a non-response option across every variable of interest, so erroneous non-responding was conflated with valid non-responding. Therefore, missing data totals cannot be estimated and the decision was made to treat missing responses as valid for all analyses.

The data file was split by advanced training to compare experience associations with IPM practices and confidence among those with and without advanced pest management training. Confidence intervals were drawn around these sets of correlations to examine whether they differed significantly.

Results and discussion

The survey was completed by 3842 MGs, or 16.7% of the 22,916 MGs in the north-central U.S. (Table 1). Roughly 41% of the final sample came from Michigan (25.8%) and Illinois (16.2%). Only 15% or 589 MGs reported they had completed advanced training in pest management within the past 5 years. Thus, the majority of MGs who participated in this survey, 85%, indicated they had no pest management training in the past 5 years (Table 1).

Nineteen percent or 749 participants were interns in their initial year of the program, 44% or 1670 had been an MG for 1 to 5 years, 25% indicated they had been in the program 6 to 10 years, 11% had 11 to 20 years, 40 or 1% had 21 to 30 years as an MG, and four participants indicated that they had more than 31 years experience in the MG program.

Almost all (99.7%) of the MGs indicated they grow flowers, followed by trees and shrubs 98%, lawn 95%, vegetables 82% and fruit 49%. Weeds were the pest category managed across plant types by the most respondents (62%), followed closely by diseases (52%), insects (47%), and wildlife (28%). Plant category had an influence: weeds were the most prevalent pest managed for flowers (86%), vegetables (83%), and lawns (84%), but disease was the most common pest (69%) for trees and shrubs. Respondents growing fruit indicated that they managed disease, insects, and weeds nearly equally (about 62%). While insects were not the main pest managed for any plant type, they were usually managed by at least 50% of respondents across all categories except lawns (36%), with the highest percentage of insects being managed for vegetables 73%. Wildlife was the least managed pest, with the lowest response for lawns, 13%, and highest for vegetables, 47%. MG pest management practices are shown in Table 2, and are the basis for IPM. Two practices were not widely used by MG: record keeping and rowcovers. Row covers were used infrequently (25%); they were used about four times more often on vegetables than other plant types (data not shown). Record keeping, a key component of IPM, is not being done by MGs according to this survey. Similar results for record keeping were found by Sellmer et al. (2003). Interestingly, these IPM pest management practice variables were all correlated substantially and positively with one another, indicating that MGs' engagement in IPM practices are often not just spread across plant types, but practice types as well (Table 3). The correlations between these variables were all highly significant and ranged from a low of r = 0.35 (between prevention and chemical awareness/control) and a high of r = 0.58 (between monitoring and cultural control).

MGs indicated their primary concerns for choosing pest management practices were (choosing no more than three): effectiveness at 79%, health and safety to family or pets at 79%, and environmental impact at 74%, and as opposed to cost of the management method at 20% or amount of time needed to use at 9%.

MGs indicated their preference for learning resources for pest management practices (Table 4). Time-sensitive extension pest management updates and tips (73%), face to face classes (72%), and online fact sheets (70%) had the highest responses. Web tools (63%) were viewed as "very helpful" resources, while self-paced

Table 3. Intercorrelations for integrated pest management (IPM) practices for Master Gardeners in 11 north-central U.S. states.

Practice	IPM intercorrelations (r)[z]			
	Prevention	Monitoring	Cultural control	Chemical control
Prevention	1.00	0.51	0.56	0.35
Monitoring	0.51	1.00	0.58	0.47
Cultural control	0.56	0.58	1.00	0.40
Chemical control	0.35	0.47	0.40	1.00

[z]All correlations are significant at $P < 0.001$.

Table 4. North-central U.S. Master Gardener preferences for learning pest management practices. Participants were instructed to control the single best answer for each learning method.

Learning method	Not very helpful	Somewhat helpful	Very helpful	Total responses (no.)
	[no. of responses (% total responses)]			
Extension online fact sheets	68 (2)	1002 (28)	2486 (70)	3556
Instructor led face to face classes	88 (3)	864 (25)	2488 (72)	3440
Instructor led online classes	518 (17)	1399 (45)	1225 (39)	3142
Self-paced online classes	494 (15)	1297 (40)	1436 (45)	3227
Time-sensitive extension pest management updates and tips	78 (2)	874 (25)	2525 (73)	3477
Web tools to help apply pest management practices	190 (6)	1040 (31)	2109 (63)	3339

Table 5. North-central U.S. Master Gardener responses to the following question: "To be confident enough to make recommendations to other gardeners, I would need more training in the following pest management practices (check all that apply)."

Topic	Responses (no.)	Response (%)
Identifying insects	2401	65
Identifying diseases	2982	81
Identifying weeds	1991	54
Monitoring pests	1825	50
Using weather or climate data to assist in determining pest management strategies	2512	68
Using plants adapted for your site and climate	940	26
Using cultural controls (resistant varieties, watering, mulching, etc.)	928	25
Using biological controls (such as beneficial insects or *Bacillus thuringiensis*)	2093	57
Using conventional (man-made) pesticides	1608	44
Using organic pesticides	2360	64

Table 6. Analysis of variance testing the role of advanced pest management training on confidence and implemented pest management practices of Master Gardeners in north-central U.S. states.

Variable	Advanced training [mean (SD)][z]	No advanced training [mean (SD)][z]	F value	P
Confidence	2.55 (0.48) (n = 588)	2.25 (0.42) (n = 3243)	245.92	0.001
Prevention	8.99 (4.04) (n = 592)	8.13 (3.81) (n = 3250)	25.01	0.001
Cultural control	15.40 (6.52) (n = 592)	14.10 (5.93) (n = 3250)	23.40	0.01
Monitoring	7.05 (3.24) (n = 592)	6.03 (3.16) (n = 3250)	51.00	0.001
Chemical control	5.47 (2.97) (n = 592)	4.79 (3.01) (n = 3250)	25.58	0.001

[z]Higher scores represent more of each attribute; see Table 2 for response ranges. Sample size differences within rows reflect missing data and valid non-responding.

Table 7. Correlation between years of experience and confidence or integrated pest management practices when compared with advanced and no advanced training among north-central U.S. Master Gardeners.

Variable	Whole sample (r)	Advanced training	No advanced training	Difference[y]
Confidence	0.26***[z]	0.33***	0.20***	0.13[z]
Prevention	0.06***	0.18***	0.02	0.16[z]
Monitoring	0.09***	0.18***	0.04*	0.14[z]
Cultural	0.06***	0.12**	0.03	0.09
Chemical	0.06***	0.09*	0.04*	0.05

[z]Significant at $*P < 0.05$; $**P < 0.01$, $***P < 0.001$.
[y]Difference is significant because 95% confidence intervals do not overlap.

or instructor-led online classes were ranked lower.

To confidently make IPM recommendations, MGs indicated a need for more training in a number of topics, including identification of diseases at 81%, insects at 65%, and weeds at 54%, as well as using weather or climate data at 68%, organic pesticides at 64%, and biological controls at 57% (Table 5). Fewer responses for using adapted plants (26%) and cultural controls (25%) indicate that the MGs are more comfortable recommending these practices to others. This may indicate that they are less complex or that MG training has covered these topics more thoroughly.

MGs with advanced training had significantly more confidence and used significantly more pest management practices and significantly more chemical controls than did MGs with no advanced pest management training in the past 5 years (Table 6). Years of experience as an active MG and confidence in knowing how to use IPM-related garden activities were correlated positively ($r = 0.261$), indicating there is a significant difference between experienced and inexperienced MGs (Table 7). Smaller, yet statistically significant, relationships between years of experience and prevention and monitoring pest management practices were also found ($r = 0.06$ and 0.09, respectively), indicating that MGs with more experience appear slightly more likely to engage in prevention and monitoring pest management practices than those with fewer years experience, although these correlations are very close to zero (Table 7).

Advanced training appears to be more important than years of experience in disposing MGs to engage in IPM-related activities. MGs in north-central U.S. states are using most components of IPM, and the more advanced training they have, the more confident they feel in making recommendations involving IPM. A large majority of participants indicated a need for more training in disease and insect management. Implications for extension educators appear to be offering more classes, especially timely updates, followed by fact sheets and face-to-face classes in pest management for MGs.

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