



Surveys and Needs Assessments

Identifying integrated pest management resource needs among Virginia Master Gardeners

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Two survey questionnaires distributed to Master Gardener (MG) volunteers in Virginia provide valuable insights into their awareness, understanding, and utilization of integrated pest management (IPM). Survey responses reveal a varied level of familiarity with IPM, with a notable percentage of respondents lacking knowledge of the term and differing perceptions of its focus on non-chemical or chemical pest control methods. While respondents generally recommended IPM solutions more than half the time, factors limiting their decision to do so included comfort level, limited understanding or knowledge, lack of training, lack of client interest, and lack of resources. The survey results highlight an agreement among respondents regarding the adequacy of state Cooperative Extension Service materials in addressing IPM. Pest management guides, websites, and fact sheets were the IPM resources most frequently used and perceived as effective. Respondents expressed a preference for fact sheets as the top resource material to enhance public training programs, followed by other multimedia content. Moreover, the survey results provide insights into the specific pest-related needs of Virginia MGs, revealing their priorities in terms of arthropod, vertebrate pest, plant disease, and weed resource topics. Overall, the data from the surveys offers a comprehensive understanding of MG perspectives on IPM, identifying areas for program improvement and providing guidance for the development of targeted resources to enhance MG knowledge and facilitate more effective public outreach.

Key words: IPM, survey, needs assessment, training, extension education

Integrated pest management (IPM) has a strong scientific foundation and a proven track record of success in various crop production settings (Norton et al. 2005, Farrar et al. 2016, Lane et al. 2022), including residential lawns and gardens (Baysal et al. 2009, Wilen et al. 2011). Despite its effectiveness, communicating with residential consumers about the impacts and benefits of IPM has posed a particular challenge. This group often lacks general IPM knowledge (Wearing 1988, Dara 2019, Diaz et al. 2020), as well as access to the educational resources and expertise needed for effective implementation of IPM strategies (Matheny et al. 2009). Given that the home and garden sector accounts for nearly 25% of total pesticide expenditures in the United States and 50% of insecticide expenditures alone (Atwood and Paisely-Jones 2017), it is essential to educate residential consumers on the importance and benefits of practicing IPM.

In the United States, Master Gardeners (MGs) are well-positioned to bridge the gap between expert knowledge and the needs of residential consumers, which can allow MGs to be effective advocates for IPM. MGs are trained volunteers who provide horticultural education and assistance within their local communities. They receive in-depth training typically administered by their state

land-grant university's Cooperative Extension Service, which covers various subject areas such as plant care, gardening techniques, environmental stewardship, and pest management (Meyer 2007). This training equips them with the knowledge to conduct community-based horticultural service projects and assist home gardeners and residential consumers with general gardening questions and problems. MGs play a valuable role in extending the knowledge and expertise within the Cooperative Extension System to wide and diverse audiences, which can ultimately lead to more successful and sustainable lawn and gardening practices in their communities (Sadof et al. 2004, Matheny et al. 2009, Wilen et al. 2011, Kowalski and Barrett 2020, Reid and Gable 2020).

As part of training programs, MGs typically receive instruction on the core principles of IPM, which include pest identification, monitoring, prevention, and the use of multiple strategies (e.g., cultural, mechanical, biological, and chemical) to manage pests in a sustainable and environmentally responsible manner. However, the specific content and depth of IPM knowledge can vary depending on the particular MG program, the local region, and the individual's training and experience (Meyer et al. 2010, Wilen et al. 2011).

Because IPM is a dynamic and knowledge-intensive practice, ongoing education and experience are key to enhancing the capacity of MGs to implement effective IPM strategies and educate clientele (Sadof et al. 2004). Access to science-based resources, reference materials, and tools to assist in educational efforts is one way to increase MGs' knowledge base and boost confidence in their ability to provide accurate and helpful guidance to others (Swackhamer and Kiernan 2005, Meyer et al. 2010, Kalaman et al. 2020).

There are 5,100 active MGs in Virginia that contribute over 255,000 h of volunteer service (K. Reed, personal communication, 12 December 2022). This is a small army of horticulture enthusiasts that can engage and educate others about the principles and practices of IPM and contribute to its wider adoption. Assessing the knowledge and resource needs of MGs with respect to IPM, along with identifying barriers to the recommendation of IPM practices, is essential for creating a well-informed and effective group of communicators. It ensures that the training and resources provided are relevant and targeted, ultimately leading to better dissemination of IPM information to the public (Meyer et al. 2010). Here, we discuss the results of 2 surveys used to assess the knowledge and educational needs of Virginia MGs concerning IPM.

Survey Methods

In an effort to evaluate and inform state-level IPM programming, 2 anonymous survey questionnaires were developed to collect information from active MGs throughout Virginia. The Virginia Tech Institutional Review Board granted an exemption for the data collection (VT IRB#: 22-206). The surveys were distributed by email through the Virginia Master Gardener listserv with approval from the Virginia State Master Gardeners Office. The first survey was distributed on 17 February 2020 and consisted of 7 questions, which gathered information on respondents' knowledge of IPM and their IPM educational resource needs (Table 1). Based on survey responses, several Virginia Cooperative Extension (VCE) fact sheets were developed and published between April and November 2020 to help expand and reinforce MGs' knowledge of IPM and aid in their communication efforts with the public. The second survey was distributed on 8 June 2021. It consisted of 10 questions to determine if MGs were aware of and using the new fact sheets, as well as to gather further information on preferences for IPM training materials and pest-specific educational resource needs (Table 2).

Qualtrics software (Provo, UT) was used to develop and conduct both survey questionnaires. A letter introducing the purpose of the survey and a message of gratitude for participation were included with each questionnaire. Survey question types consisted of open response, Likert scale, yes/no, multiple answer, and rank choice. Each survey remained open for 4 weeks. All data were imported into Microsoft Excel (Redmond, WA) for analysis.

Survey Results

The 2020 survey was completed by 602 MGs (11.8% response rate). Among the respondents, 7.5% did not know the term IPM. An additional 8.0% of respondents indicated that IPM focuses on non-chemical or organic pest control methods, while 1.7% of respondents indicated that IPM focuses on the use of pesticides. When asked how often respondents recommend IPM solutions when working with clients, the median response on a Likert scale from 1 to 5 (1 = never, 5 = always) was 4 (mean 3.3), indicating more than half the time. When asked which factors limited a respondent's decision to recommend IPM solutions, comfort level received the greatest number of responses (91), followed by limited understanding or knowledge (70), lack of training (68), lack of client interest (51), and lack of resources (17). When asked if VCE resources adequately address IPM, the median response on a Likert scale from 1 to 5 (1 = strongly disagree, 5 = strongly agree) was 4 (mean 3.5), indicating agreement. When asked to select the VCE resources respondents use to interact with the public, pest management guides, websites, and fact sheets received the greatest number of responses (395, 393, and 388, respectively), followed by MG training materials (307), and agent interactions (171). When asked to indicate which VCE resources effectively cover IPM, pest management guides received the greatest number of responses (351), followed by fact sheets (259), websites (251), MG training resources (195), and agent interactions (192). The final question of the 2020 survey allowed for open-ended feedback on what IPM topics respondents felt needed to be addressed. The 6 most cited categories included non-chemical and organic pest management solutions (23.5%), general IPM (19.5%), pest-specific IPM practices (17.7%), facilitating the accessibility of IPM information within pest management guides (16.0%), beneficial species and pollinators (10.6%), and pesticide application and safety (5.5%).

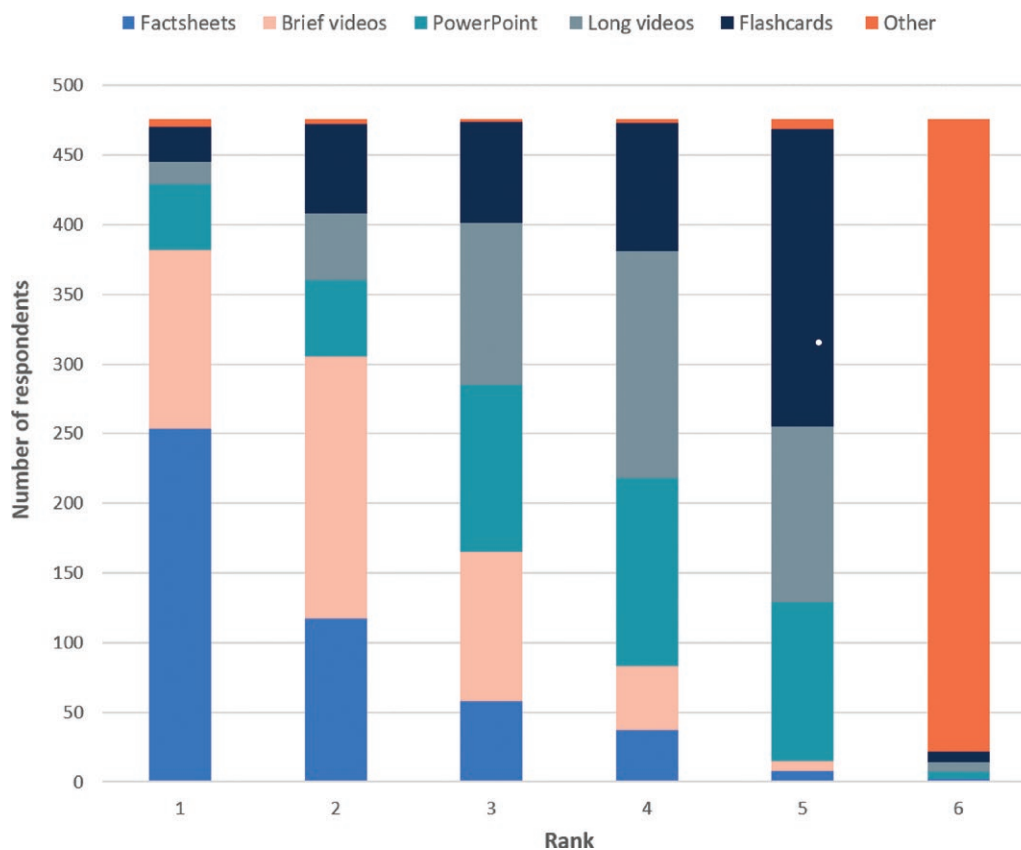
The 2021 survey was completed by 719 MGs (14.1% response rate). At the time of the survey, only 10.8% of respondents were aware of the new VCE fact sheets developed to help strengthen Virginia MGs' knowledge of IPM topics. Of these respondents, 47.4% (37) indicated they had accessed the IPM publications for their own personal education, and 19.2% (15) indicated they had used the publications in training activities with the public. When all respondents were asked if fact sheets were efficient tools for educating the public, the median response on a Likert scale from 1 to 5 (1 = strongly disagree, 5 = strongly agree) was 5 (mean 4.3), indicating strong agreement. When asked to rank the types of resource materials respondents would use to enhance public training programs, fact sheets were rated highest, followed by brief videos (2–5 min), PowerPoint presentations with slide notes, long videos (7–10 min), flashcards with pictures and descriptions of IPM tactics and concepts, and other resources (Fig. 1). The final questions of the 2021 survey asked respondents to rank their needs for IPM resources related to arthropods, vertebrate pests, plant diseases, and

Table 1. Seven-question survey distributed to Virginia MGs in 2020 with percentage response ($n = 602$) to specific questions

Question	Response rate (%)
1. When you hear the term IPM, what does it mean to you? (open answer)	97.2
2. When working with clients, how often do you recommend IPM solutions? (0–5 scale)	98.7
3. Please select the factors that limit your decision to recommend IPM solutions (multiple answer).	37.5
4. Do you feel that current Virginia Cooperative Extension resources for Master Gardeners adequately address IPM? (0–5 scale)	90.7
5. What Virginia Cooperative Extension resources do you use to interact with homeowners? (multiple answer)	90.5
6. Select the Virginia Cooperative Extension resources that effectively cover IPM (multiple answer).	84.2
7. Is there an IPM topic that you think needs to be addressed? (open answer)	48.7

Table 2. Ten-question survey distributed to Virginia MGs in 2021 with percentage response ($n = 719$) to specific questions

Question	Response rate (%)
1. Were you aware of the 7 new fact sheets listed in the letter? (yes or no)	100.0
2. If you were aware of the fact sheets, have you accessed them for your own personal education? (yes or no)	9.7
3. Have you used any of the fact sheets in training activities for the public? (yes or no)	9.7
4. If you used any of the fact sheets in training activities for the public, which publications have you used? (multiple answer)	2.1
5. Please indicate your degree of agreement with the following statement: “Fact sheets are efficient tools for educating the public.” (0–5 scale)	73.8
6. What types of IPM-related materials would you use to enhance public training programs? (rank choice with open answer opportunity)	66.2
7. What arthropod-related IPM topics should be addressed next? (rank choice with open answer opportunity)	69.9
8. What vertebrate animal-related IPM topics should be addressed next? (rank choice with open answer opportunity)	64.8
9. What plant disease-related IPM topics should be addressed next? (rank choice with open answer opportunity)	67.6
10. What plants as pests (weeds)-related IPM topics should be addressed next? (rank choice with open answer opportunity)	68.7

**Fig. 1.** Respondents' ranked choices of resource materials they would use to enhance public training programs (where 1 is most preferred and 6 is least preferred).

weeds. For arthropod IPM, the need for pollinator resources was ranked highest, followed by resources on beneficial arthropods (non-pollinators), vegetable pests, invasive species, ticks, mosquitoes, ornamental plant pests, turf pests, urban pests, and other arthropod pests (Fig. 2). For vertebrate pest IPM, the need for deer resources was ranked highest, followed by resources on moles and voles, rabbits, mice, coyotes, and other vertebrate pests (Fig. 3). For plant disease IPM, the need for vegetable pathogen resources was ranked highest, followed by resources on pathogens of ornamental plants, tree fruit, turf, and other plants (Fig. 4). Finally, for weed IPM, the need for resources on invasive species was ranked highest, followed by resources on weeds in vegetable gardens, turf, ornamental beds, and other sites (Fig. 5).

Conclusions and Implications

The 2020 survey reveals a notable gap in IPM awareness among a segment of Virginia MGs, with 7.5% of respondents indicating they were unfamiliar with the term. An additional 9.7% of respondents associated IPM solely with non-chemical and organic pest control methods or linked it exclusively to pesticide use. These findings underscore the need for further targeted educational efforts to enhance the understanding of IPM concepts among Virginia MGs. We believe that providing clear and comprehensive definitions, particularly during initial MG training, would help to better align perceptions and create a common foundation for further training.

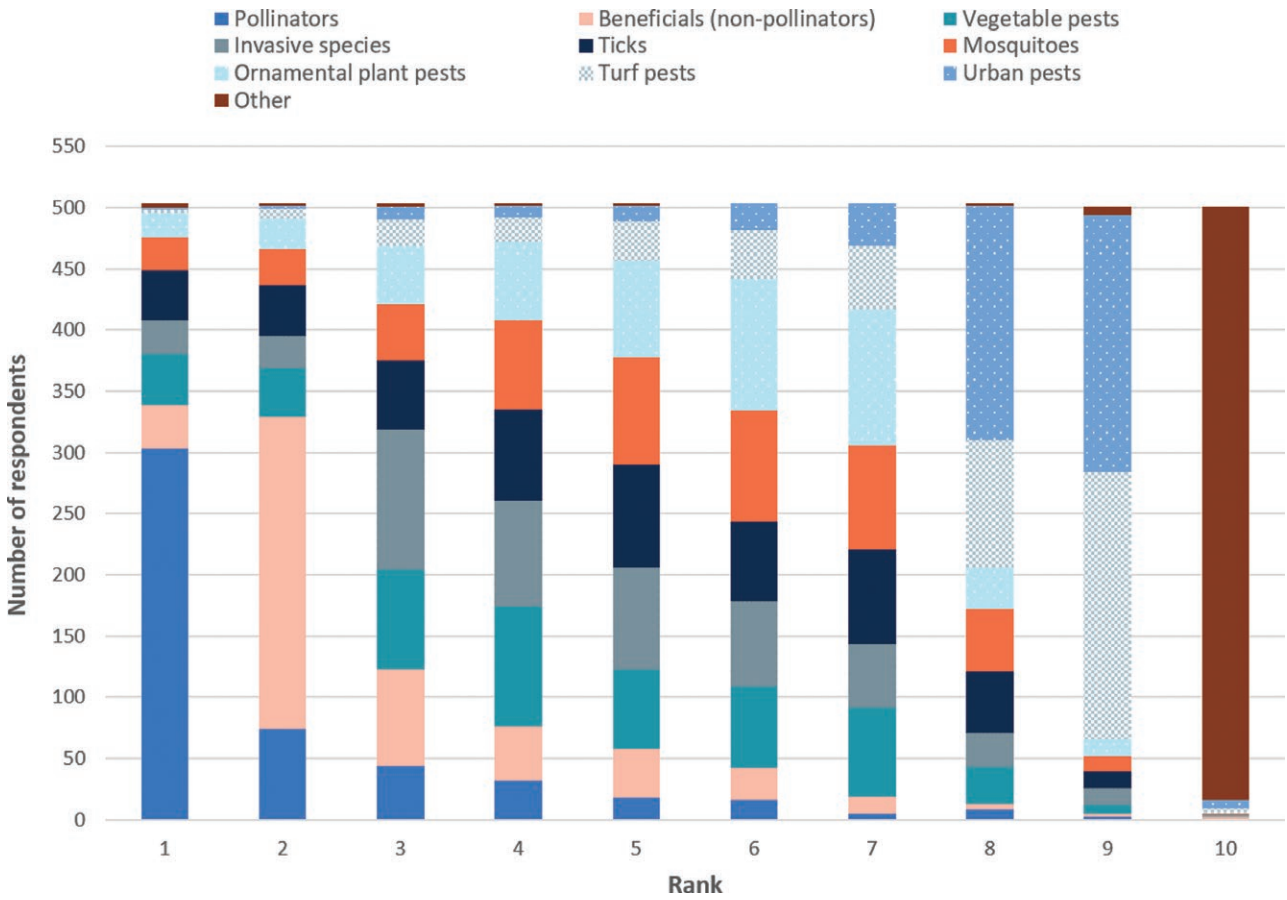


Fig. 2. Respondents’ ranked choices of arthropod-related IPM resource needs (where 1 is most important and 10 is least important).

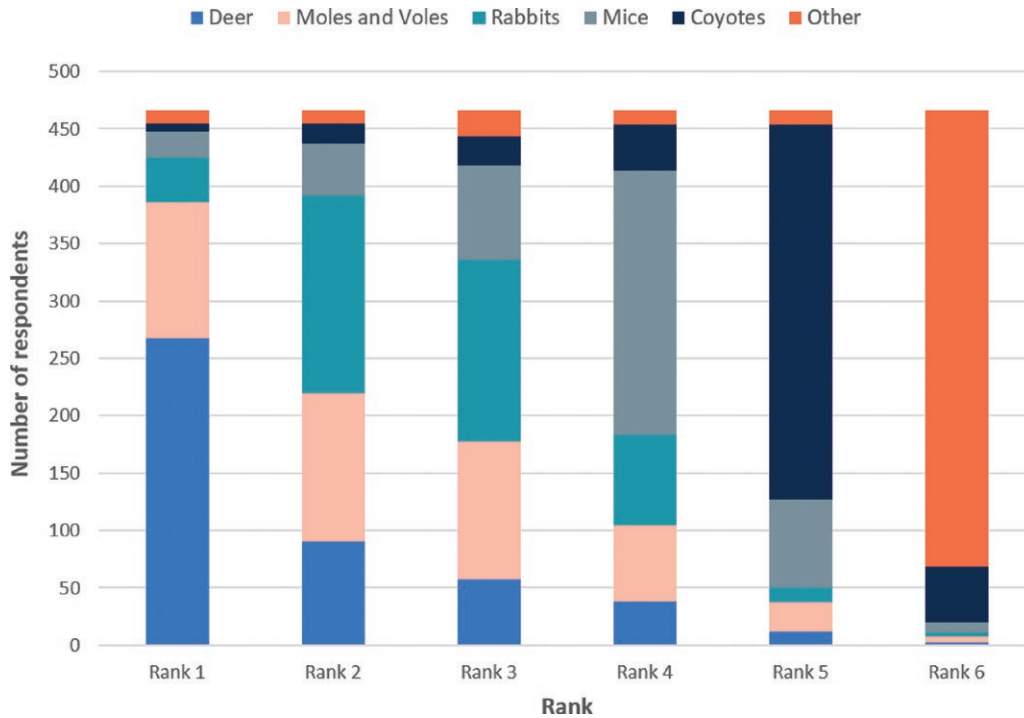


Fig. 3. Respondents’ ranked choices of vertebrate pest-related IPM resource needs (where 1 is most important and 6 is least important).

Although Virginia MGs suggested IPM solutions to clientele more than half the time, additional efforts should be directed toward increasing the frequency of IPM recommendations and adoption.

The most frequently cited barrier among respondents was comfort level, highlighting a potential need for confidence-building measures in IPM practices. Limited understanding or knowledge and

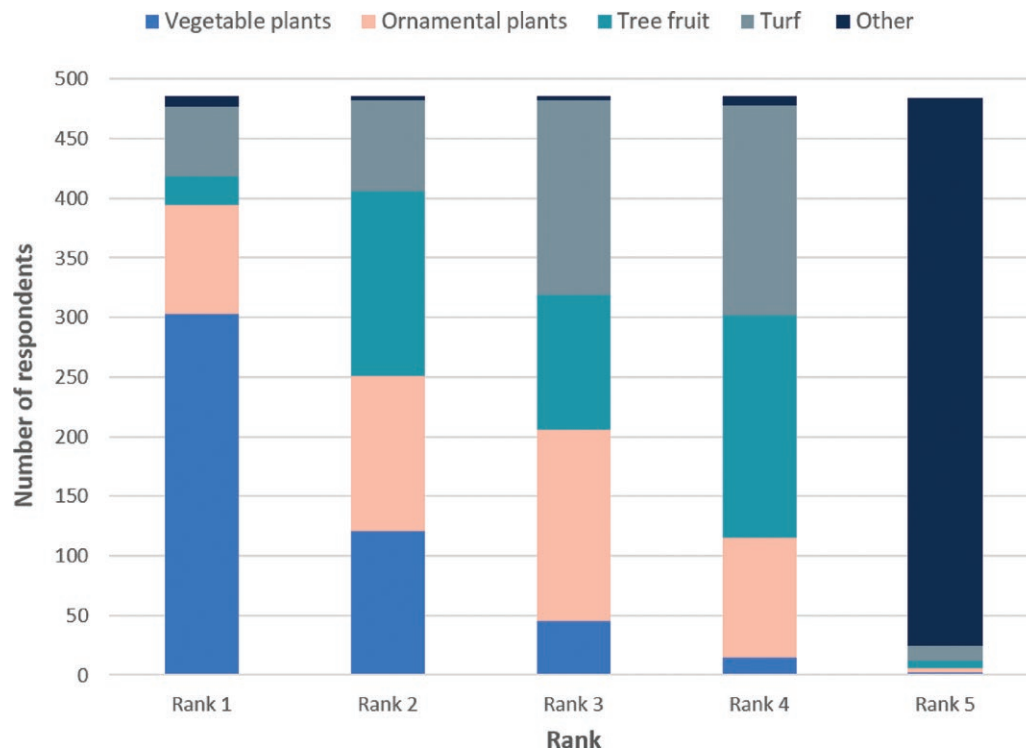


Fig. 4. Respondents' ranked choices of plant disease-related IPM resource needs (where 1 is most important and 5 is least important).

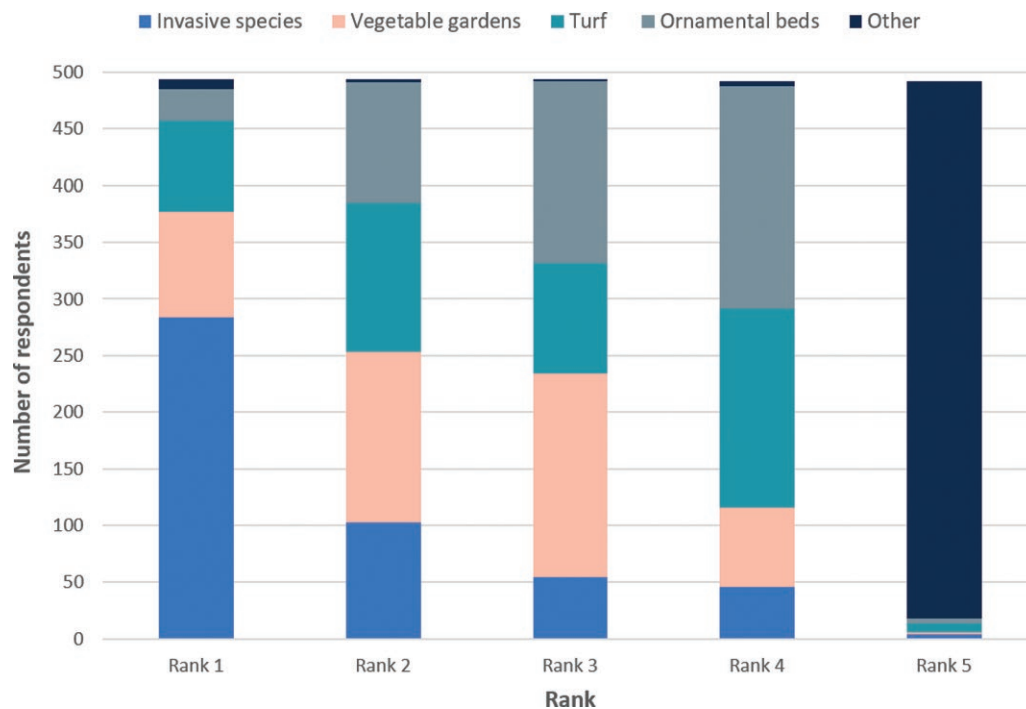


Fig. 5. Respondents' ranked choices of weed-related IPM resource needs (where 1 is most important and 5 is least important).

lack of training also emerged as major hurdles. This suggests that education is key to the successful implementation of IPM programs among MGs. Lack of knowledge and/or training has often been cited as the largest perceived impediment to IPM adoption among various segments of the population (Wearing 1988, Dara 2019, Diaz et al. 2020). Additional targeted educational programs and training sessions have been shown to enhance MGs' confidence and

proficiency in recommending and adopting IPM practices (Israel et al. 1999, Sadof et al. 2004, Swackhamer and Kiernan 2005, Meyer et al. 2010).

Regarding state Cooperative Extension Service resources, MGs agreed that they effectively addressed IPM. The identification of pest management guides, fact sheets, and websites as the most utilized VCE resources suggests the importance of enhancing and promoting

these materials. Addressing specific respondent concerns, such as emphasizing and facilitating the accessibility of content within pest management guides, particularly on non-chemical and organic pest management solutions, general IPM, and pest-specific practices, could improve their effectiveness in supporting MGs' needs. Moreover, incorporating these subjects into in-person training sessions, a favored modality of instruction among MGs (Meyer et al. 2010, Kalamani et al. 2020), can further augment educational efforts.

The findings from the 2021 survey provide valuable insights into the awareness and utilization of specific VCE fact sheets among MGs, with a particular focus on their role in enhancing knowledge about IPM topics. The survey reveals that a relatively small percentage of respondents were aware of the new VCE fact sheets designed to bolster their understanding of IPM. Despite the modest level of awareness, those who were familiar with the fact sheets demonstrated a positive engagement. Nearly half of the respondents who knew about the fact sheets indicated they had accessed the publications for their personal education. In addition, 19.2% reported using the fact sheets for training activities with the public. This suggests that among those who were aware of the resources, there was a willingness to incorporate them into both personal learning and outreach activities. Additional future efforts should be made to advertise newly developed resources to MGs to increase their awareness and usage.

The 2021 survey further explored the perceived efficiency of fact sheets as tools for educating the public about IPM. There was strong agreement among respondents that fact sheets are effective tools for public education on IPM topics. Moreover, when asked to rank various types of resource materials for enhancing public training programs, fact sheets were the most preferred resource. Similarly, Meyer et al. (2010) showed that fact sheets were a preferred resource among MGs in the north-central United States. The preference for fact sheets and other written materials may reflect a desire for easily accessible and digestible information. However, the positive response to videos and presentations in our survey shows the value that multimedia content may have in conveying complex concepts. For example, Parker et al. (2011) showed that video was the most preferred educational delivery strategy among older adult populations, with twice as many individuals expressing a preference for it over PowerPoint presentations. Furthermore, Langworthy (2017) showed that short-form educational videos (5–8 min) tend to garner more views, shares, and likes from viewers compared to full-length seminar videos.

The prioritization of resource needs across different categories, including arthropods, vertebrate pests, plant diseases, and weeds, offers a better understanding of the challenges faced by MGs, and can serve as a guide for future education efforts. In the context of arthropod IPM, resources on pollinators and beneficial (non-pollinator) arthropods emerged as the highest-ranked selections, underscoring the growing recognition of the critical role they play in ecosystem health and agricultural productivity (Novacek 2008, Garibaldi et al. 2013, Rader et al. 2015). The high prioritization of beneficial arthropods also supports Virginia MGs high interest in non-chemical and organic pest control methods. The prominence of deer as the highest-ranked selection in vertebrate pest resource needs aligns with the considerable impact these animals can have on residential, agricultural, and natural landscapes (Gill 1992, Côté et al. 2004, Witches et al. 2013). Vegetable plant pathogens emerged as the top priority in plant disease resource needs, reflecting the economic significance plant pathogens have on the yield and quality of crops that constitute a substantial portion of the human diet (Savary et al. 2019). Finally, in the realm of weed resource needs, the emphasis

on invasive species as the highest-ranked selection supports the considerable ecological and economic threats posed by these species (Baider and Florens 2011, Funk et al. 2013).

Overall, the data from the survey questionnaires illuminates both the progress made and the challenges that remain in advancing IPM education among MGs. Tailored educational initiatives, resource development, and addressing specific barriers can collectively contribute to a more informed and confident community of MGs, thereby promoting the widespread implementation of IPM practices among the general public. Our findings underscore the importance of providing diverse educational materials, with an emphasis on written resources such as fact sheets, supplemented by multimedia content, to effectively enhance MGs' knowledge and facilitate their public training programs on IPM topics.

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Author contributions

Daniel Frank (Conceptualization, Data curation, Formal analysis [equal], Funding acquisition [lead], Investigation, Methodology, Project administration, Resources, Software [equal], Supervision [lead], Validation, Visualization [equal], Writing—original draft [lead], Writing—review & editing [equal]) and Stephanie Blevins-Wycoff (Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing—review & editing [equal])

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Data availability

The data presented in this study are available on request from the corresponding author.

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