FUTURE TRENDS IN PESTICIDE APPLICATION

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Abstract - The pest control industry has historically been driven by the developments of new and better chemistry. Equipment needs of the industry have traditionally lagged behind the needs of the industry - leaving pest control companies to often invent and modify their own equipment. With the effectiveness of modern chemicals and the large drive toward Integrated Pest Management (IPM), the most limiting factor of the pest control industry is the need for equipment which far surpases traditional equipment. Surveys of the equipment needs for pest control have been conducted for several years, showing trends over time. Future development needs as well as current trends in equipment are reviewed in relation to the needs of the chemicals and the practices of the worldwide industry.
Key words - Integrated pest management, pest control, rodent control, equipment.

INTRODUCTION

The materials available for controlling household pests and the means of applying them have improved steadily over the last fifty years. The introduction of cyclodienes, organophosphates, and carbamates for household pests generated a need for appropriate application equipment. At first, the equipment, like the chemicals, were adaptations from agricultural uses and not suited for indoor use. Gradually, delivery systems were developed specifically for treating household substrates. For as long as liquids were the dominant format for delivering insecticides indoors, the one-gallon compressed-air sprayer with pin stream and fan spray nozzles was sufficient. Rodent control followed the same path in that traps and a few rudimentary baits were the extent of the technology. Changes would occur when chemical and equipment manufacturers realized the economic importance of household pest control.

The most significant change in household pest control has been the amount of chemical and carrier applied. Whether for insects or rodents, pesticide delivery has evolved from an agricultural-like broadcast spray (or rodent baiting) to exposed surfaces to the selective placement of limited amounts. For insects, the fan spray nozzle has given way to the crack and crevice straw; for rodents there are more efficient baits and traps. Improved active ingredients and formulations from manufacturers were matched with new and improved equipment. The result of this evolution of chemicals and delivery systems has been more effective pest control with the efficient use of chemicals in the living space. This trend is likely to continue with the development of baits, the use of pheromones to trap or disrupt pest activity, and the improvement of nonchemical control strategies (Snell, 1998).

The objectives of this paper are to review the current features of insect and rodent control delivery systems for household pests and the professional pest control industry, and to provide some perspective on the future direction of application equipment with the changes in the frequency and pest status of insects and rodents in the living space. Before discussing the present and future of delivery systems, the increase in importance of integrated pest management or control programs to the pest control industry will be considered. This concept will have a significant influence on household pest control in the next century.

IPM and pesticide application

Clearly, the professional pest control (residential and commercial) market worldwide is adopting the concept of integrated pest management, or at least the paradigm of using more than one control method. In many companies the phrase IPM is a convenient short-hand term for including baits and sticky traps into the regular monthly treatment, for others it means a sincere effort to move away from

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scheduled sprays to treat when and where needed. The (more common) one-dimensional perception of IPM may be driven primarily by the lack of tools (as well as training) geared for the precision, low volume needs of a balanced IPM program. Due to such gaps in the equipment arsenal, pest control operators routinely choose the easiest means of performing IPM, which is with baits and sticky traps. However, changes in delivering dust and granules to indoor and outdoor sites, and the improved aerosol delivery systems provide opportunities for integrating formulations and treatment sites.

A liquid sprayer and a bulb duster were the standard tools of the professional pest control industry in the past due to the industry's dependence on liquids and dust. As in the past, the chemistry available and understanding of the target pest drives the equipment needs of today. Pest control operators need a wider variety of tools which deliver less volume. If a function such as fogging or aerosol void flushing is only needed on rare occasions in present day pest control, the service technician will be less willing to carry a larger piece of equipment and may eliminate the function from his routine entirely. If that function can be filled through the use a smaller product, it will be more likely to be incorporated into an integrated program. Therefore, new equipment developments must be designed to encompass more functions into smaller packages.

Advancements in equipment design are critical to the further development of the IPM for the urban environment. In evaluating the trends of IPM in this setting, it is important to acknowledge the differences between IPM in agriculture and urban. The concept of tolerance levels or action thresholds has received little or no research (Snell and Robinson, 1991), and in fact may be of little or no practical use (Robinson, 1996, 1999). For most urban (household and structural) pests there is zero tolerance (Wood *et al.*, 1981), and control strategies must focus on prevention and the mere appearance of the pest in the living space. Along similar lines, the use of monitoring devices for making control decisions have not been fully developed for household and structural IPM programs (Jacobi and Robinson, 1997; Forschler and Robinson, 1999).

Integrated pest management will have a strong influence on modern termite and rodent control programs as well as general pest control. The chemical control of subterranean termites is likely to continue to move in the direction of baiting and monitoring methods, with perhaps selective use of liquids or other chemical formulations. Again, this one-dimensional approach to integrated programs will change only when termiticide application equipment (delivery) is matched with improved active ingredients, and the two are developed in concert. The use of aqueous foam to deliver termiticides is an example of a missed opportunity for joint development of chemicals and delivery systems. This technology can effectively deliver liquid to voids beneath concrete slabs with the need for few access holes, but termiticide labels and regulatory restrictions limit hole spacing further than 18 inches (45 cm).

Rodent management programs have long had a wide variety of equipment available, including snap traps, bait stations, glue boards, and multiple catch stations. However, as the rodent problems subside in most developed countries, placement of rodent equipment will be justified more by combining uses with general pest control and other functions such as monitoring and baiting for other ground-dwelling pests. These features are becoming available with some new rodent-control stations. Since much of rodent control is related to leave-behind equipment, the need for preventing all pests as well as leaving a reminder of the pest control efforts to the customers will dictate the incorporation of rodent related equipment into future programs.

Future trends in pesticide application equipment

It is difficult to accurately predict the changes in any market, and professional pest control is no exception. However, there are some aspects of this industry, such as the basic commercial and residential need for this service, that provides a relatively stable base and makes it somewhat predictable. In an effort to monitor the changes occurring in pesticide application, and to anticipate the equipment needs of the industry, I have conducted a survey of the equipment use by leading pest control companies. The information was obtained by sending a questionnaire to the technical directors three separate times during the last five years. The majority of the companies were based in the United States, but

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10% were from other countries. The objective was to quantify pest control practices at the time of each survey and to project the changes over the following three to five years.

The following data is from one of the questions in the questionnaire sent to the same group of people. The question asked the participants to rank the use of a specific piece of equipment or pest control practices as a percentage of the total insect control methods now, and what they expect it to be 3-5 years from now. Tables 1 to 3 present the survey data for the 1995 (14 respondents), 1997 (27 respondents), and the 1999 (36 respondents), respectively.

Table 1. Survey of pest control equipment (n=14).

Application Method	Used Now	Percentage change
Liquid sprayer	28.70	55.05
Aerosols, containerized	18.40	7.07
ULV	6.40	25.00
Dust, crack and crevice	4.90	2.04
Dust, voids	2.20	27.27
Bait, stations	7.60	(2.63)
Bait, paste and gel	8.60	87.21
Baits, granular	4.80	(8.33)
Caulk and sealing	3.90	133.33
Sticky traps, monitors	15.40	20.78
Other: vacuum, power-spray, MultiJector		

Table 2. Survey of pest control equipment (n=27).

Application Method	Used Now	Future	Percentage change
Liquid sprayer	26.70	14.96	(43.97)
Aerosols	16.74	11.48	(31.97)
ULV	6.44	7.67	18.97
Crack and crevice dust	6.70	8.04	19.89
Void dusts	2.89	2.30	(20.51)
Bait stations	6.33	7.07	11.70
Bait paste and gel	15.30	22.04	44.07
Granular baits	6.56	6.67	1.69
Caulk and sealing	1.39	2.98	114.67
Sticky traps, monitors	7.15	11.33	58.55
Vacuum	1.24	5.13	313.43
Other: power-spray, backpacks, mechanical methods			

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Table 3. Survey of pest control equipment (n=36).

Application Method	Used Now	Future (3-5 yr)	Percentage change
Liquid sprayer	19.42	9.00	(53.65)
Aerosols	7.21	6.03	(16.35)
ULV	3.21	3.22	0.38
Crack and crevice dust	4.71	5.29	12.44
Void dusts	2.06	2.21	7.31
Bait stations	9.97	12.87	29.03
Bait paste and gel	22.99	25.91	12.73
Granular baits	7.47	9.59	28.32
Caulk and sealing	1.63	4.44	173.30
Sticky traps, monitors	8.50	13.74	61.59
Power sprayers	8.78	6.03	(31.31)
Backpack sprayers	3.94	2.10	(46.69)
Vacuum	1.24	5.13	313.43
Other: granular insecticides, vacuum biological insecticides, light traps			

1995. In 1995 the survey results indicated that the primary insecticide application tool was the compressed air sprayer (28.7%), followed by containerized aerosols (18.4%), and sticky traps and other pest monitors (15.4%) (Table 1). The respondents predicted a 55% decline in the use of liquid sprayers in their programs, and 7% decline in aerosol use. Growth was anticipated in the use of sticky traps and other monitors (17% increase), paste and gel baits (47% increase), and caulking and sealing material (57%). The use of aerosols to treat voids (primarily indoor wall voids) was projected to increase slightly from 6.4% to 8%. No significant change was predicted for bait stations, crack and crevice application of dusts, granular baits, and dusting of large voids.

1997. In 1997 little change was evident in the use of sprayers (26.7%), but the respondents indicated sprayers would decline in use by 44% in the upcoming years (Table 2). Aerosols were again ranked as the second most common application technique, but they were also predicted to decline, by as much as 31%. The use of baits increased over 1995, increasing from 8.6% (1995) to 15.3% (1997). This increase was predicted by the respondents in 1995. It is likely that the use of sticky traps and monitors were overestimated in the 1995 survey. Their use was only 7.2% in 1997 and predicted to increase by 59% in the upcoming years. Treating voids with aerosols was essentially unchanged (6.4%) for 1995 and 1997. Vacuuming as a pest control method began to be listed more often in 1997, and was predicted to increase significantly, although still a low percentage of the overall control techniques.

1999. The data from the 1999 survey is significant because it was collected four years after the 1995 survey, and within the 3-5 year time given the respondents for future predictions. Use of sprayers did not decline as much as predicted in 1995, but did drop to 19.4% (compared to 28.7% in 1995). Respondents predicted that the use of sprayers would a continued to decline and they would be only 9% of the total application methods. Aerosol use dropped significantly in the fours years to only 7.2% compared to 18.4% in 1995. Bait pastes and gels increased more than predicted in 1995,

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and as much as predicted (23%) only two years previously. This change escalated baits from the forth most important pest control tool in 1995, to the third in 1997, and the first in 1999. Bait stations increased more than predicted in 1995 or 1997 to a total of 10% in 1999 (third most important technique). Sticky traps and monitors have still not quite become as routine as expected in the 1995 and 1997 predictions. They continues to hold a distant fifth place in priorities of pest control technicians. The use of caulking as a control strategy has not been significant over the entire four year study.

Indicated trends. The survey data indicate that the pest control industry can reasonably predict the changes in equipment and product use. The decline of the German cockroach as the primary household pests in the United States (Robinson, 1999) and other parts of the world (Landau *et al.*,1999) has occurred during the last five years. Concurrently, the pest status of ants has increased dramatically during this period the decline in the use of cockroach baits will likely be compensated by an increase in the use of ant baits and bait stations.

The use of sticky traps and monitors has not been integrated into commercial and residential pest control programs as quickly as desired by the target audience. In the 1995 survey the respondents predicted four tools would dominate (64.7%) insecticide application in the future: sprayers, sticky traps, aerosols, and gel baits. In 1997 the same four tools were predicted to make up 60% of the applications.

The use of baits for a variety of indoors and outdoor pests will probably continue to increase in the coming years. If the current trends holds, baits will most likely dominate the application methods in the professional pest control industry. The four years of these surveys have most likely chronicled the shift away from sprayers and to nearly completely to bait guns. The need to squeeze a trigger and displace material may continue to be the most difficult habit pest control companies must overcome in their technicians. As cockroach problems continue to decline, the need for any one chemical also declines. The technique of carefully monitoring and inspecting, followed by careful placement of the best application method, may be bypassed in favor of constant applications of baits.

Lastly, the pest control industry in general is spending little time training in the use, understanding or maintenance of new equipment. This is due in large part to the trend toward a more varied application approach and current lack of use of traditional equipment such as sprayers, bulb dusters, and liquid termiticide application tools. This trend can also be an effect of the higher need for training about the pest biology, pesticide chemistry, regulations, and other topics that are becoming more important. Regardless of why the trend, equipment is expected to be simpler, more reliable, and require less routine maintenance (if any) than products of the past.

Perspective on application equipment

Combined functions. New equipment in the past five years show a strong trend toward multiple use. This is evidenced by tools that combine termiticide application valves and perimeter spraying. Bait guns will be able to apply pastes, gels, dusts, and granular baits with interchangeable components. Rodent control equipment now can be used to monitor ground level pests, such as ants, and stored product pests (with pheromone attractants). Small vacuums have recently been introduced that combine suction with blowing to create aerosol void flushers and other pest control functions.

Less complicated and smaller. Making equipment less complicated is somewhat contrary to the need for more functions in each component. However, there is some evidence that equipment will gradually improve in this area. New foaming technology provides the ability to foam under flooring without any adjustments of valves or other components compared to the complicated traditional foamers. New pint and gallon compressed air sprayers are pressurized by compressors in order to eliminate several parts and some complication due to sprayer pumping assemblies.

There are many pint-sized sprayers available due to the increased demand for less chemical on a job site. This is an area that is all but impossible for the pest control operator due to the packaging of chemicals without instructions or methods for mixing small quantities. Therefore, service technicians often prepare a large quantity of material at one time when only a small amount will be used, and the remainder stored.

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Truck mounted spray rigs for termiticide injection and broadcast spraying have been evolving slowly for many years. There have been many failed attempts at systems to attach to returnable pesticide containers in order to eliminate vulnerable 25-100 gallon storage tanks. There are now injection pump systems that mechanically siphon material directly from the pesticide container. These units are somewhat smaller but require a second hose reel to attach to the customers water supply (in place of a tank). This technology is growing slowing in a few countries but is still considered too complicated by many. Others are concerned with the liability of transporting large volumes of chemicals on the truck.

Increased precision and accuracy. Recent trends have seen many improvements in the development of more precise and effective equipment. Sprayer tips have been designed to increase coverage of liquid inside cracks and crevices. Dusters are now available that delivery the same amount of dust or granular bait with each pull of the trigger. Baits guns have been designed to deliver small, precise amounts of paste/gel baits. Liquid termite tools have been designed to give better distribution of materials under flooring. Methods have recently been created that can increase the penetration depth of liquid into wood surfaces. Equipment has also been designed to apply a variety of ant and general pest baits so that the changing nutritive needs of the target pest(s) can be met.

Prepackaged products and delivery systems. The prepackaged paste and gel baits which mate with bait guns may point to another trend in equipment development. This offers opportunities for prepackaged dusts and granular baits to minimize technician exposure and increase application precision. Other kinds of equipment has been developed to attach to pre-pressurized aerosols. With the reduced time on training equipment and increased concern over technician exposure, additional technology is needed for mating with prepackaged materials.

Critical issues of future:

There are many parallels between the chemical industry and equipment industry. Both industries historically have used technology developed for agriculture and modified it for pest control. Like chemical development, it has become more and more important to include research into pest biology and habits in the development of equipment. The overwhelming problem for both chemical and equipment development is the small market we are servicing. The worldwide pest control industry is comparatively small as industries go and offer little or no overlap with related markets to justify expensive development budgets. The nature of such a small market is that specialized equipment costs more than seems justified compared to larger markets.

The pest control industry needs very fast development cycles of new equipment because it is currently in a turbulent time with decreasing pest populations, changing importance of target pests, new application techniques, and new chemistry. Equipment development must attempt to account for the needs of the worldwide pest control market because the needs of any one country barely justifies the development costs. However, most countries are in very different stages of pest control evolution and this is rarely practical. Perhaps the most important change in the future of equipment development for pest control will be confidential agreements for co-development efforts with chemical companies and equipment companies. This will ensure that equipment needs keep up with chemical developments and revolutionary chemistry is not left in a laboratory due to inefficient application methods.

REFERENCES CITED

Forschler, B. T. and Wm. H Robinson. 1999. Ants and subterranean termites in the urban environment: The terminology of population management control tactics. In W. Robinson and G. W. Rambo, eds. Proc. 3rd Internat. Conference on Urban Pests, Prague, Czech Republic.

Jacobi, H. and Wm. H Robinson. 1997. Monitoring. Pest Control Technology 25 (3): 34, 35, 38, 43, 110.

Landau, I., C. Muller, and M. Schmidt. 1999. The Urban Pest Advisory Service of Zurich (Switzerland) and the situation of some selected pests. In: W. Robinson and G. Rambo, eds; Proc. 3rd Inter. Conference on Urban Pests, Prague, Czech Republic.

Robinson, W. 1996. Integrated pest management in the urban environment. Amer. Entomologist 42 (2): 76-78.

Proceedings of the 3rd International Conference on Urban Pests.
Wm H. Robinson, F. Rettich and G.W. Rambo (editors). 1999.

Robinson, W. 1999. Integrated pest management and insecticide resistance management in the urban environment.. In W. Robinson and G. Rambo, eds, Proc. 3rd Internat. Conf. on Urban Pests, Prague, Czech Republic.

Snell, E. 1998. Equipment. In S. Hedges, ed., Handbook of Pest Control by A. Mallis, Franzak & Foster, Cleveland, Ohio, pp. 1186-1248.

Snell, E. and Wm. H Robinson. 1991. German cockroach pest management. Pest Control Technology 19 (8): 30-34.

Wood, F. E., Wm. H Robinson, S. K. Kraft, and P. A. Zungoli. 1981. Survey of attitudes and knowledge of public housing residents toward cockroaches. Bull. Entomol. Soc. Am. 27: 9-13.