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# Pesticide Use On Greenhouse Vegetable Crops in Ohio

OSU Cooperative Extension Service
The Ohio State University

# Pesticide Use on Greenhouse Vegetable Crops in Ohio — 1978

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## Introduction

Consultation with Ohio Cooperative Extension Specialists and associated research scientists in Entomology, Horticulture, and Plant Pathology indicated that the surveys for pesticide use in Ohio should be extended to the greenhouse industry. Although on the basis of total crop acreage and associated pesticide use the quantity of pesticides used may be very minimal in comparison to that used on field crops, the information derived could be very significant in determining critical and/or essential uses and associated cultural practices in greenhouse cropping. Not very much information relative to chemicals and practices used in pest control is available concerning the greenhouse crop industry. Survey data would thus be very important in establishing and/or confirming benefit-use information for the protection of essential pesticide registrations and indicate areas for which minor crop-minor use pesticide registrations should be sought.

Greenhouse agriculture in Ohio has two major product inputs: greenhouse vegetables, particularly tomatoes, wherein Ohio production ranks first in the U.S., and greenhouse floral and nursery crops. This publication will report pesticide use on vegetable crops and a subsequent publication will be directed toward the greenhouse floriculture industry. Support for these surveys was provided by the Ohio State Pesticide Impact Assessment Program.

## Procedures

A survey questionnaire was prepared similar to that used for the survey of pesticide use for fresh market vegetable crops (Bulletin 648. OCES, 1979) and mailed in early December 1978 with a letter of introduction and request for cooperation to the 86 members of the Cleveland Greenhouse Cooperative Association and the Ohio Greenhouse Cooperative Association. Membership lists were provided by Extension Specialists and researchers associated with the greenhouse vegetable industry. The lists constituted almost all the known growers as of 1976-77. A second request to return the completed questionnaire was mailed to non-respondents in mid-January.

## Results

Thirty-six of the greenhouse vegetable growers responded to the survey. Of these, four indicated they were no longer in the business or else had converted their operation to the floral industry, and two others with out-of-state addresses did not respond. Thus, the results of the survey are based upon data from 32 growers of 80 on the list. No information is availabel relative to the activity of the 48 Ohio growers who didn't respond. Consequently, it is possible that some of them are no longer in operation and it may be that some other current growers may not have been included on the 1976-77 listings. Responses were received from growers in Avon (2 of 8), Brooklyn Heights (1 of 2), Cincinnati (5 of 7), Cleveland (5 of 18), Columbia Station (1 of 3), Elyria (4 of 10), Hinckley (1 of 1), Jefferson (1 of 1), Lodi (1 of 1), Madison (1 of 1), Medina (3 of 3), Milford Center (1 or 1), North Ridgeville (4 or 5), Oberlin (1 of 1), Olmsted Falls (1 of 7), Parma (1 of 1), and Youngstown (2 of 2). One response for business operation in Ohio was received from out-of-state. There were no responses from Berlin Heights, Canfield, Delta, Huron, Kent, Lorain, Napoleon, North Olmsted, Swanton, and Valley City, where the listings indicated growers were located.

A summarization of the response to the survey relative to the corps grown and the size of operation of the respondents is recorded in Table 1. The acreage of greenhouse vegetable crops grown in Ohio as determined by consultation with the Extension Specialists and research scientists involved is indicated in Table 2. Table 2 also lists the acreages of crops reported from the survey returns and the percent of acreage treated for pest control. All of the greenhouse vegetable crops reported, involving 98 percent of the total acreage, were treated for insect control. Fungicides were applied only to cucumbers and tomatoes with 53 and 47 percent, respectively, of that acreage receiving treatment. Survey reports indicated that herbicide use for weed control in vegetable greenhouses was a very infrequent practice. Only one grower of those that responded indicated the use of sodium arsenite for the control of weeds in walkways. Because of the insignificance of the quantity, 2½ gallons of formulation, no projection is attempted for calculating state use.

The quantities of pesticides used in the greenhouse vegetable industry in Ohio during 1978 are recorded in Table 3. The data are recorded in pounds of active ingredient and are listed by the trade and/or common name used in the survey return. Approximately 87.5 percent of the total insecticides applied to greenhouse vegetable crops was used on tomatotes which constituted 76.6 percent of the vegetable acreage. Cucumbers, constituting 6.2 percent of the acreage, received 7.8 percent of the insecticides, and lettuce with 14.6 percent of the acreage received 4.5 percent of the insecticides. Tomatoes accounted for 90.9 percent of the fungicide utilization, and cucumbers accounted for the remaining 9.1 percent. All of the Ethrel used as a growth regulator or aid in ripening was applied to tomatoes.

In the production of greenhouse tomatoes, three chemicals accounted for 59.3 percent of the total amount of pesticides used: captafol (28.2%) used for control of fusarium crown and root rot, methomyl (18.2%) mostly for control of white fly and leafminer, and diazinon (12.9%) for control of leafminer. Following in order of decreasing percent, malathion accounted for 7.4%, benomyl - 7.4%, Calcium Cyanide - 5.7%, dimethoate - 4.5%, maneb - 3.7%, naled - 3.3%, and endosulfan - 2.9%. The major uses for these pesticides and the major pests of concern are listed in Table 4. The ten remaining pesticides accounting for 5.8 percent of the total usage, although used in significantly smaller quantities or constituting only a low percentage of the respective formulations, were also significantly important in pest control as indicated in Table 4.

Resmethrin (42.0%) and captafol (37.8%) were the major pesticides used on cucumbers, accounting for 79.8 percent of the total. The major uses of resmethrin and captafol, respectively, were for control of white fly and protection of subsequent tomato plantings from plant rots. Lesser amounts of methomyl (5.7%), copper (5.2%), ethion (2.4%) and dichlorvos (2.1%) were used for various pest control. The remaining seven pesticides used on cucumbers as indicated in Table 3 accounted for the balance of 4.8% of the total used, but again as indicated in Table 4 were important in pest control.

Malathion used mainly for control of aphids accounted for 45.2 percent of the insecticides used on lettuce. Thiodan use amounted to 24.8 percent of the total and was used also mainly for control of aphids. Of the remaining 30 percent, mevinphos (7.9%), Pyrethrin (6.9%), dichlorvos (4.8%), and lindane or Gamma isomer of BHC (3.9%) accounted for 23.5% of the use and the other four chemicals the balance of the 6.5 percent. The major uses of these insecticides are listed in Table 4. No fungicides nor growth regulators were reported as being used on lettuce.

Only one pesticide, mevinphos, was reported as being used on the limited acreage of radishes for control of aphids and response from the growers showed only 30% of the surveyed acreage being treated. Likewise, only naled was reported as used for insect control on the limited acreage of watercress. Malathion was the only pesticide reported being used on cabbage and peppers, but the extent of survey response was insignificant and there was no estimate available of the total state acreage for these two greenhouse vegetable crops.

Information related to the procedures in pesticide application is recorded in Table 5. Most pesticides were applied by broadcasting or fogging procedures and almost exclusively by the greenhouse operator. Eighty-one percent of those who responded to the survey were certified pesticide applicators. Also 93.8 percent of the respondents had facilities for steam in the greenhouse and used this method for sterilization of the greenhouse soil. In most cases the use of methyl bromide for soil fumigation was a supplemental procedure in facilities that were equipped for steam sterilization.

The use of protective clothing and equipment by greenhouse vegetable growers who apply pesticides is shown in Table 6. The data seem to indicate that applicators recognize the advisability of wearing protective gear for personal safety during pesticide applications in an enclosed area. This is evident from the report of one or more articles of protective clothing or equipment being utilized by a significant percentage of the applicators for each of the pesticides listed except Captan, lindane, and methyl bromide. Of particular note is the percentage of applicators who used a respirator or gas mask and rubber or neoprene gloves, especially when applying the pesticides that ranged in the higher toxicity levels. However, it is also noted that a large percentage of growers do not utilize adequate personal protection.

Pesticide storage facilities and procedures used by greenhouse vegetable growers are reported in Tables 7, 8, and 9. Indications are that most greenhouse vegetable growers do not have separate facilities for storing pesticides and that only approximately 40 percent utilize recommended procedures in separating pesticides by a barrier from other materials when stored in the same building, have facilities for temperature control and air movement, and are concerned with fire protection. However, 59.3 percent of the growers keep the pesticide storage area locked with 40.6 percent restricting access to only authorized personnel. All of the growers who responded indicated that they kept the pesticides in the original containers, and 31.2 percent reported that their housekeeping included separation and segregation of the different pesticides. Although the data reported in Table 7 indicate some inadequacies in storage facilities and procedures, it appears that greenhouse vegetable growers may be more in compliance with safe storage practices than many other grower groups.

Partially because of a limited number of pesticide chemicals used, a limited quantity generally needed, and the practice of growing more than one crop during the year, greenhouse vegetable growers have negligible problems in disposing of surplus pesticides. Approximately 78 percent store the pesticide for use in the next growing season and 9.4 percent use the material for some other labelled use (Table 8). Survey results relative to the disposal of surplus pesticides indicated that

12.5 percent of the growers utilized the facilities of commercial waste disposal companies, 9.4 percent buried the material in an isolated area, and 6.2 percent used incineration facilities. No growers admitted to disposal of material in the sewer systems.

The reasoning indicated in the preceding paragraph is also likely accountable for fewer problems experienced by greenhouse vegetable growers in the disposal of empty containers. As evidenced by the data in Table 9, 56.2 percent of the growers decontaminated the containers prior to disposal and then 34.4 and 25.0 percent, respectively, disposed of the containers on the premises by burning or burial. Commercial waste disposal companies and sanitary landfill facilities were used by 43.8 and 21.9 percent, respectively, of the growers to handle empty containers. Only a very small percentage of growers indicated disposal procedures that are not in conformance with good safety practices.

Greenhouse vegetable growers rely greatly upon the recommendations of the Cooperative Extension Service via bulletins and Extension Agents as the information source for pesticide application (Table 10). As a second priority for information after the Extension Agent, they seek the counsel of the chemical representative or dealer and rely upon their own personal experience. They also consider the compatibility of the pesticide application with existing equipment to be the most important economic factor in pesticide selection rather than the cost of the pesticide per area or unit treated (Table 11). Relative to the criteria of toxicity level of chemicals in selecting pesticides, most growers were concerned with the time interval involved between application and subsequent contact with or harvesting the crop as evidenced by the responses of 26.7 percent selecting chemicals on the basis of lower toxicity and 30 percent on a short time interval to harvest (Table 11). Another 10 percent chose pesticides requiring limited or no personal protective gear. To 13.3 percent of the growers, the major concern was satisfactory pest control, regardless of the toxicity of the pesticide; and another 13.3 percent selected on the basis of prolonged pest control. The fact that the application of some pesticides required applicator certification did not seem to be a major concern of the responding growers.

## Discussion

A general observation in summarizing the survey questionnaire returned indicates that many greenhouse vegetable growers are not as knowledgeable in the use of pesticides or do not maintain records as accurate as is desirable. However, there were also many who provided information in detail. In several instances respondents indicated that they applied pesticides at the rates and intervals recommended by Cooperative Extension Service personnel, but they didn't record the rate nor the number of applications that coincided with the total quantity of pesticide reported as used for that particular crop. Some growers indicated several chemicals used when checking the list of pesticides sent with the survey for information or indicated some pesticides used in combination with others for pest control, but then failed to include such data in listing the pesticides and quantities used on particular crops.

In several instances the grower response to the suspected causes of crop loss did not coincide with the report on the target pest for which particular pesticides were used. In other words, although the pesticide used was registered for the pest to which the grower attributed the crop loss, the entry did not indicate that pest as the reason for using the pesticide. In some other cases the use of viable pesticides was not recorded for the control of such specified pests. There was, therefore, reason to question in some cases whether or not the grower could adequately evaluate the effectiveness of his spray program and the actual causes of suspected crop losses.

It appears that as a grower group, greenhouse vegetable growers have fewer problems in complying to safe pesticide use practices than perhaps other groups. Reasoning may be that there are fewer crops of concern but similar pest problems for all crops which minimize the number of different pesticides that are recommended and consequently used. An enclosed environment causes growers to be more concerned perhaps than certain other groups in personal safety. Less quantity of pesticides, of course, reduces the magnitude of the storage and disposal problem, but on the other hand, could also be a reason for complacency in providing for adequate facilities and procedures.

The total quantity of pesticide active ingredient used in the greenhouse vegetable industry is very minimal compared to other agricultural industries. In 1978 only 4,158 pounds of active ingredient insecticide and 2,716 pounds active ingredient fungicide were used for greenhouse vegetables. Consequently, the conclusion could be that the use is insignificant and of no consequence in the overall picture of pesticide registrations. However, even though the acreages involved are very minor, the continued availability of registered pesticides is very critical for a successful operation and the greenhouse vegetable industry is very significant in Ohio agricultural production.

**Table 1: Characteristics of Greenhouse Operations from Survey Respondents**

| | Area Range of Crop Production (1000 sq. ft.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Crop | <1 | 1-5 | 5-10 | 10-25 | 25-50 | 50-100 | 100-150 | 150-200 | >200 |
| Cabbage | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cucumber | 1 | 4 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| Lettuce | 0 | 1 | 1 | 0 | 2 | 6 | 4 | 1 | 0 |
| Peppers | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Radish | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| Tomatoes | 0 | 1 | 0 | 2 | 5 | 10 | 7 | 2 | 2 |
| Watercress | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

## Table 2: Pesticide Usage on Greenhouse Vegetable Crops — 1978

| Crop | Acreage | | Acreage Treated for Control of | | | | | |
|---|---|---|---|---|---|---|---|---|
| | State Total* | Surveyed | Weeds | | Insects | | Disease | |
| | | | % | Acres | % | Acres | % | Acres |
| Cucumber | 17.0 | 2.84 | 0.0 | 0.0 | 96.0 | 16.3 | 53.0 | 9.0 |
| Lettuce | 40.0 | 27.08 | 0.0 | 0.0 | 100.0 | 40.0 | 0.0 | 0.0 |
| Radish | 4.0 | 2.64 | 0.0 | 0.0 | 30.0 | 1.2 | 0.0 | 0.0 |
| Tomatoes | 210.0 | 62.57 | 0.0 | 0.0 | 100.0 | 210.0 | 47.0 | 98.7 |
| Watercress | 1.5 | 0.50 | 0.0 | 0.0 | 100.0 | 1.5 | 0.0 | 0.0 |
| Cabbage | ** | 0.01 | 0.0 | 0.0 | 100.0 | ** | 0.0 | 0.0 |
| Peppers | ** | .006 | 0.0 | 0.0 | 100.0 | ** | 0.0 | 0.0 |
| Other | 1.5 | — | — | — | — | — | — | — |
| Total | 274.0 | 95.646 | 0.0 | 0.0 | 98.0 | 269.0 | 39.0 | 107.7 |

* Acreages estimated from best knowledge of personnel in the Entomology, Horticulture, and Plant Pathology Departments, O.S.U.

** Estimate of acreage not known but included in total of other crops.

## Table 3: Pesticides Used on Greenhouse Vegetables in Ohio — 1978

| Pesticide | | Quantity (lbs) of Active Ingredient Used on | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Common Name | Trade Name | Cabbage* | Cucumber | Lettuce | Radishes | Peppers* | Tomatoes | Watercress | Empty Greenhouse | Totals |
| **A. Insecticides** | | | | | | | | | | |
| Lindane | Aphid Smoke<br>Gamma Isomer BHC | | | 7.34 | | | | | | 7.34 |
| Calcium Cyanide | Cyanogas<br>Sno-Gas | | | | | | 353.1 | | | 353.1 |
| Dimethoate | Cygon | | | 3.32 | | | 275.2 | | | 278.52 |
| Diazinon | | | | 2.95 | | | 799.9 | | | 802.85 |
| Naled | Dibrom | | 0.72 | | | | 205.1 | 6.0 | | 211.82 |
| Dichlorvos | DDVP | | 11.97 | 9.0 | | | | | | 20.97 |
| B. Thuringiensis | Dipel | | 0.18 | 3.39 | | | 5.3 | | | 8.87 |
| Ethion | | | 13.47 | | | | | | | 13.47 |
| Methomyl | Lannate | | 32.32 | 2.66 | | | 1,124.3 | | | 1,159.28 |
| Malathion | | 0.36 | 0.24 | 84.93 | | 0.18 | 459.5 | | | 545.21 |
| Oxythioquinox | Morestan | | | | | | 5.0 | | | 5.0 |
| Parathion | | | 8.98 | | | | 79.7 | | | 88.68 |
| Mevinphos | Phosdrin | | | 14.77 | 1.5 | | | | | 16.27 |
| Piperonyl Butoxide | Piperonyl Butoxide<br>Fog Con 3610 | | | | | | 37.2 | | | 37.2 |
| Pyrethrins | Pyrethrin<br>Fog Con 3610 | | | 12.92 | | | 47.1 | | | 60.02 |
| Tedion | | | 8.98 | | | | | | | 8.98 |
| Endosulfan | Thiodan | | 7.18 | 46.68 | | | 182.2 | | | 236.06 |
| Totals | | 0.36 | 323.78 | 187.96 | 1.5 | 0.18 | 3,638.0 | 6.0 | 0.0 | 4,157.78 |
| **B. Fungicides** | | | | | | | | | | |
| Metam-sodium | Vapam | | | | | | 30.2 | | | 30.20 |
| Benomyl | Benlate | | | | | | 454.9 | | | 454.9 |
| DCNA | Botran | | 1.26 | | | | 30.9 | | | 32.16 |
| Captan | | | | | | | 10.1 | | | 10.1 |
| Copper | | | 29.93 | | | | | | | 29.93 |
| Captafol | Difolatan | | 215.49 | | | | 1,745.2 | | | 1,960.69 |
| Maneb | Dithane<br>Maneb | | | | | | 228.2 | | | 228.2 |
| Totals | | 0.0 | 246.78 | 0.0 | 0.0 | 0.0 | 2,469.3 | 0.0 | 0.0 | 2,715.98 |

## Table 3: Pesticides Used on Greenhouse Vegetables in Ohio — 1978—cont.

| Pesticide | | Quantity (lbs) of Active Ingredient Used on | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Common Name | Trade Name | Cabbage* | Cucumber | Lettuce | Radishes | Peppers* | Tomatoes | Watercress | Empty Greenhouse | Totals |
| **C. Growth Regulators** | | | | | | | | | | |
| Ethephon | Etherel | | | | | | 75.2 | | | 75.2 |
| **D. Soil Fumigants** | | | | | | | | | | |
| Methyl Bromide | | | | | | | | | 8,250.0 | 8,250.0 |
| Total Pesticides | | 0.36 | 570.46 | 187.96 | 1.5 | 0.18 | 6,182.5 | 6.0 | 8,250.0 | 15,198.96 |

* State estimates on Cabbage and Pepper greenhouse acreages are not available and the surveyed acreage was so small that extrapolation for state totals is not possible.

## Table 4: Major Pests and Pesticides Used for Greenhouse Vegetable Crops

| Crop | Pesticide | Major Pests Reported[1,2] |
|---|---|---|
| Cabbage | Malathion | Aphids |
| Cucumber | B. thuringiensis | (Cabbage looper) |
| | Captafol | (To protect tomatoes in subsequent cropping) |
| | Copper | 3 |
| | DCNA | (White mold) |
| | Dichlorvos | (Aphids, leafminer, spider mites, thrips, white fly) |
| | Endosulfan | White fly, spider mites, leafminer |
| | Ethion | 3 |
| | Malathion | White fly, spider mites |
| | Methomyl | (White fly) |
| | Naled | (Aphids, flea beetle, leafminer, spider mites, white fly) |
| | Parathion | 3 |
| | Resmethrin | White fly |
| | Tedion | (Spider mite) |
| Lettuce | B. thuringiensis | Cabbage looper, cutworms |
| | Diazinon | Aphids |
| | Dichlorvos | Aphids |
| | Dimethoate | Leafminer |
| | Endosulfan | Aphids |
| | Lindane | Aphids |
| | Malathion | Aphids |
| | Methomyl | Aphids |
| | Mevinphos | Aphids |
| | Pyrethrin | Aphids, worm moth |
| Radishes | Mevinphos | Aphids |
| Peppers | Malathion | Aphids |
| Tomatoes | B. thuringiensis | Cabbage looper |
| | Benomyl | Botrytis rot |
| | Calcium cyanide | White fly |
| | Captafol | Fusarium crown and root rot |
| | Captan | Botrytis |
| | DCNA | Botrytis |
| | Diazinon | Leafminer, sowbugs |
| | Dimethoate | Leafminer |
| | Endosulfan | White fly, leafminer |
| | Ethephon | Ripening |
| | Malathion | White fly, cabbage looper, leafminer, Aphids |
| | Maneb | Leaf mold, mildew |
| | Metam-sodium | Soil sterilization |
| | Methomyl | White fly, leafminer |

[1] Pests listed in descending order of frequency reported by growers.

[2] Information in parentheses lists pests for which the pesticide has recommendation, but growers did not indicate the pest associated with the particular chemical use.

[3] Blank spaces indicate that the pesticide was not registered for such use and the grower gave no indication of the pest for which such material was used.

## Table 4: Major Pests and Pesticides Used for Greenhouse Vegetable Crops—cont.

| Crop | Pesticide | Major Pests Reported[1,2] |
|---|---|---|
| | Naled | White fly |
| | Oxythioquinox | Mildew |
| | Parathion | White fly, cabbage looper, leafminer, spider mites |
| | Pyrethrin | White fly, worm moth |
| | Resmethrin | White fly |
| Watercress | Naled | 3 |
| Empty greenhouse | Methyl bromide | Soil fumigation |
| Walkways | Sodium arsenite | Weed control |

[1] Pests listed in descending order of frequency reported by growers.

[2] Information in parentheses lists pests for which the pesticide has recommendation, but growers did not indicate the pest associated with the particular chemical use.

[3] Blank spaces indicate that the pesticide was not registered for such use and the grower gave no indication of the pest for which such material was used.

## Table 5: Procedures Used in Pesticide Application

| Pesticide | Crop | Method of Application (percent) | | | |
|---|---|---|---|---|---|
| | | Broadcast | Fog | Irrigation | Other |
| B. thuringiensis | Cucumbers | 100.0 | | | |
| | Lettuce | 29.6 | 70.4 | | 15.2[1] |
| | Tomatoes | 91.8 | | 3.2 | |
| Benomyl | Tomatoes | 70.4 | 20.4 | | |
| Calcium cyanide | Tomatoes | 100.0 | | | |
| Captafol | Cucumbers | | | 100.0 | |
| | Tomatoes | | | 100.0 | |
| Captan | Tomatoes | 100.0 | | | |
| Copper | Cucumbers | 100.0 | | | |
| DCNA | Cucumbers | | | | 100.0[2] |
| | Tomatoes | 97.8 | | | 2.2[2] |
| Diazinon | Lettuce | | | 100.0 | |
| | Tomatoes | 36.4 | 63.1 | 0.5 | |
| Dichlorvos | Cucumbers | | 100.0 | | |
| | Lettuce | 100.0 | | | |
| Dimethoate | Lettuce | | 100.0 | | |
| | Tomatoes | 95.0 | 5.0 | | |
| Endosulfan | Cucumbers | 100.0 | | | |
| | Lettuce | 44.6 | 55.4 | | |
| | Tomatoes | 85.3 | 14.7 | | |
| Ethephon | Tomatoes | 100.0 | | | |
| Ethion | Cucumbers | 100.0 | | | |
| Lindane | | | | | |
| Aphid Smoke | Lettuce | | 100.0 | | |
| Gamma-Isomer BHC | Lettuce | 100.0 | | | |

[1] Pesticide applied as a Drench
[2] Pesticide applied with paintbrush on the plant stem
[3] Pesticide applied as a soil fumigant

## Table 5: Procedures Used in Pesticide Application—cont.

| Pesticide | Crop | Method of Application (percent) | | | |
|---|---|---|---|---|---|
| | | Broadcast | Fog | Irrigation | Other |
| Malathion | Cabbage | 100.0 | | | |
| | Cucumbers | 100.0 | | | |
| | Lettuce | 35.3 | 64.7 | | |
| | Peppers | 100.0 | | | |
| | Tomatoes | 67.1 | 32.9 | | |
| Maneb | | | | | |
| Dithane | Tomatoes | 100.0 | | | |
| Maneb | Tomatoes | 100.0 | | | |
| Metam-sodium | Tomatoes | | | | 100.0[3] |
| Methomyl | Cucumbers | 100.0 | | | |
| | Lettuce | | | 100.0 | |
| | Tomatoes | 48.2 | 51.5 | 0.3 | |
| Methyl bromide | Empty greenhouse | | | | 100.0[3] |
| Mevinphos | Lettuce | 15.0 | 75.0 | 10.0 | |
| | Radishes | | | 100.0 | |
| Naled | Cucumbers | 100.0 | | | |
| | Tomatoes | 38.0 | 62.0 | | |
| | Watercress | 100.0 | | | |
| Oxythioquinox | Tomatoes | 100.0 | | | |
| Parathion | Cucumbers | | 100.0 | | |
| | Tomatoes | | 100.0 | | |
| Piperonyl butoxide | Tomatoes | | 100.0 | | |
| Pyrethrins | | | | | |
| Fog Con 3610 | Tomatoes | | 100.0 | | |
| Pyrethrin | Lettuce | | 100.0 | | |
| | Tomatoes | 47.0 | 53.0 | | |
| Resmethrin | Cucumbers | 0.1 | 99.9 | | |
| | Tomatoes | 1.0 | 99.0 | | |
| Tedion | Cucumbers | 100.0 | | | |

[1] Pesticide applied as a Drench
[2] Pesticide applied with paintbrush on the plant stem
[3] Pesticide applied as a soil fumigant

## Table 6: Protective Gear Utilized by Growers in Association With Pesticide Mixing, Handling, and Application

| Pesticide | Percent of User Personnel Using Protective Gear | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of Users Reported | Face Shield or Goggles | Respirator or Gas Mask | Rubber or Plastic Apron | Water Resistant Spray Suit | Rubber or Neoprene Gloves | Rubber or Neoprene Boots | Washable Head Covering |
| B. Thuringiensis | 10 | 30 | 50 | 10 | 30 | 30 | 30 | 30 |
| Benomyl | 6 | 17 | 34 | | 17 | 34 | 17 | 34 |
| Calcium cyanide | 5 | | 40 | | | 20 | | 40 |
| Captafol | 4 | 24 | 50 | | 50 | 25 | 50 | 25 |
| Captan | 1 | | | | | | | |
| Copper | 2 | 50 | 50 | | 50 | 50 | 50 | 50 |
| DCNA | 2 | 50 | 50 | | 50 | 50 | 50 | 50 |
| Diazinon | 12 | 25 | 83 | | 42 | 75 | 42 | 50 |
| Dichlorvos | 2 | 50 | 100 | | | 50 | | |
| Dimethoate | 4 | 50 | 75 | | 50 | 75 | 50 | 75 |
| Endosulfan | 9 | 33 | 78 | | 11 | 33 | 22 | 11 |
| Ethephon | 2 | | 50 | | 50 | 50 | | 50 |
| Ethion | 1 | 100 | 100 | | 100 | 100 | 100 | 100 |
| Lindane | 2 | | | | | | | |
| Malathion | 12 | 33 | 58 | | 25 | 33 | 17 | 33 |
| Maneb | 3 | 67 | 33 | | 33 | 33 | 33 | 67 |
| Metam-sodium | 1 | | | | | | | |
| Methomyl | 15 | 47 | 87 | | 40 | 73 | 53 | 40 |
| Methyl bromide | 1 | | | | | | | |
| Mevinphos | 3 | 67 | 100 | 33 | 100 | 100 | 100 | 100 |
| Naled | 5 | 20 | 20 | | | 20 | | |
| Oxthioquinox | 1 | | 100 | | | | | |
| Parathion | 2 | 50 | 100 | | 50 | 100 | 50 | 100 |
| Piperonyl butoxide | 2 | | 50 | | | | | |
| Pyrethrins | 5 | 20 | 80 | | 20 | 40 | | 60 |
| Resmethrin | 3 | 67 | 33 | 33 | 33 | 33 | 33 | 33 |
| Tedion | 1 | 100 | | | 100 | 100 | 100 | 100 |

## Table 7: Procedures Used by Greenhouse Vegetable Growers in Pesticide Storage

| | Pesticide Storage Procedure | Practiced by Growers (%)* |
|---|---|---|
| 1. | Stored in a separate building. | 9.4 |
| 2. | Stored in building housing other materials. | 40.6 |
| 3. | same as 2 but separated by a barrier. | 40.6 |
| 4. | Kept under locked storage. | 59.3 |
| 5. | Storage area is fireproof. | 6.2 |
| 6. | Storage area has facilities for fire protection. | 31.2 |
| 7. | Storage area has facilities for temperature control. | 37.5 |
| 8. | Storage area has facilities for air movement. | 40.6 |
| 9. | Storage area has provisions for separation and segregation of pesticides. | 31.2 |
| 10. | Storage area is equipped with isolated drainage system. | 12.5 |
| 11. | Storage area is accessible only to authorized personnel. | 40.6 |
| 12. | Pesticides are sometimes stored in other than the original container. | 0.0 |

* The percentage total exceeds 100% because more than one procedure may apply to an individual grower's pesticide storage practice.

## Table 8: Procedures Used by Greenhouse Vegetable Growers in Disposing of Surplus Pesticides.

| | Pesticide Storage Procedure | Practiced by Growers (%)* |
|---|---|---|
| 1. | Surplus pesticide stored for use in next growing season. | 78.1 |
| 2. | Surplus pesticide returned to dealer. | 0.0 |
| 3. | Surplus pesticide utilized for some other labeled use. | 9.4 |
| 4. | Surplus pesticide diluted and sprayed over isolated area. | 3.1 |
| 5. | Surplus pesticide buried in isolated area. | 9.4 |
| 6. | Surplus pesticide burned or incinerated | 6.2 |
| 7. | Surplus pesticide disposed of in a landfill operation. | 3.1 |
| 8. | Surplus pesticide disposed of by a commercial waste disposal company. | 12.5 |
| 9. | Surplus pesticide disposed of in environmental, municipal, or public sewer system. | 0.0 |

* The percentage total exceeds 100% because the grower may utilize more than one procedure for disposing of surplus pesticide.

## Table 9: Procedures Used by Greenhouse Vegetable Growers in Disposing of Empty Containers

| | Pesticide Storage Procedure | Practiced by Growers (%)* |
|---|---|---|
| 1. | Metal and plastic containers are decontaminated by triple rinse or similar procedure. | 56.2 |
| 2. | Combustible containers are burned on premises. | 34.4 |
| 3. | Containers are buried on premises. | 25.0 |
| 4. | Containers are disposed of in sanitary landfill facilities. | 21.9 |
| 5. | Large containers are returned to the dealer or manufacturer. | 3.1 |
| 6. | Containers are disposed of through barrel reclaimers. | 3.1 |
| 7. | Containers are disposed of through commercial waste disposal companies. | 43.8 |
| 8. | Containers are sometimes used for other purposes. | 3.1 |
| 9. | Containers accumulate on premises. | 0.0 |
| 10. | Containers are dumped at out-of-way places. | 0.0 |
| 11. | Containers are stored for future disposal. | 0.0 |
| 12. | Storage facilities for empty containers are similar to or the same as that for pesticide storage and are kept locked. | 3.1 |

* The percentage total exceeds 100% because growers may utilize more than one procedure for disposing of empty containers.

## Table 10: Information Sources Growers Prefer in Selection of Pesticides

| | Information Source | Grower Response (%) First Priority | Second Priority |
|---|---|---|---|
| A. | Recommendation of dealer | 6.7 | 40.0 |
| B. | Recommendation of neighbor | 0.0 | 16.0 |
| C. | Recommendation of Extension Agent | 80.0 | 6.0 |
| D. | Advertisements from companies | 0.0 | 6.0 |
| F. | Personal experience | 13.3 | 32.0 |

## Table 11: Factors Considered the Most Important by Greenhouse Vegetable Growers in Selection of Pesticides

| Factor | | Grower Response (%) |
|---|---|---|
| 1. | Economic Factors | |
| | A. Cost per unit treated | 36.7 |
| | B. Compatability with existing equipment | 63.3 |
| 2. | Personal Hazard Factors | |
| | (Given the choice between two chemicals of equal control potential, indicate the criteria you would use to make your choice.) | |

| | | First Priority | Second Priority |
|---|---|---|---|
| A. | Choice of chemical with lower toxicity. | 26.7 | 28.5 |
| B. | Choice of chemicals requiring less personal protection. | 10.0 | 17.9 |
| C. | Choice of chemicals not requiring applicator certification. | 6.7 | 3.6 |
| D. | Deciding factor is satisfactory pest control; toxicity of chemical is of secondary consideration. | 13.3 | 3.6 |
| E. | Choice of chemicals with short treatment to harvest day-waiting-time. | 30.0 | 28.5 |
| F. | Choice of chemicals with prolonged control. | 13.3 | 17.9 |