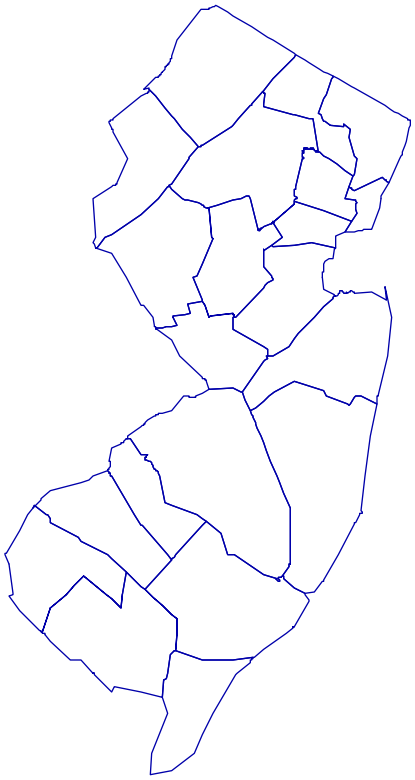
N.J. Department of Environmental Protection and Energy
Pesticide Control Program

RUTGERS COOPERATIVE EXTENSION
NEW JERSEY AGRICULTURAL STATION

AGRICULTURAL PESTICIDE USE IN NEW JERSEY



A Survey of Private Applicators in 1985 and 1988

Background

In 1978, the New Jersey Department of Health attempted to estimate agricultural pesticide usage by requesting County Extension Agents to estimate the acres planted with particular crops and then further estimate the pesticide burden for each crop. This data, while useful as an initial estimate, did not provide information below the county level and could not be effectively used in planning environmental monitoring or impact projects. Since New Jersey's agricultural sector is complex, accurate pesticide use data is critical. Even though relatively small in size, over 800,000 acres of land are devoted to agriculture, with most involved in crop production. The agricultural industry in New Jersey produces 72 vegetables, 10 fruit, and 8 grain commodities. It ranks in the top five states in the production of blueberries, cabbage, cranberries, peaches and snap beans (New Jersey Department of Agriculture, 1988). Due to this wide diversity of crops, there is a corresponding diversity in the types and amounts of pesticides used in the state. Over 10,000 products, containing over 400 major active ingredients, are currently registered for use as pesticides in New Jersey.

While there are several different methods for estimating pesticide usage, they do not provide a complete usage pattern. Federal agencies and individual states employ methods such as dealer sales records, surveys of growers in selected target areas, and surveys of pesticide use on major crops to determine trends of usage. In a state such as New Jersey, a more complete pattern of use is needed, since the boundaries between agricultural lands and residential areas are vague in many areas. The distribution of New Jersey's agricultural industry in suburban and urban, as well as rural areas, makes the need for specific data imperative, in order to better evaluate the impact of pesticides in the state.

In order to address the need for information on the types, amounts, and locations of pesticides currently in use, the Pesticide Control Program (PCP) in the New Jersey Department of Environmental Protection and Energy (NJDEPE) with the assistance of Rutgers Cooperative Extension (RCE) conducted pesticide use surveys in 1986 (1985 usage) and 1989 (1988 usage) of New Jersey's certified private applicators (farmers). The recording and submission of pesticide use data is governed under the New Jersey Pesticide Control Code (NJAC 7:30-1 et. seq.), which requires private applicators to maintain application records for all pesticides applied and gives the PCP the authority to request accurate pesticide use data from certified pesticide applicators. A farmer is classified as a private applicator: one applying pesticides for the production of an agricultural commodity on land that he/she either owns or rents. Over 3,000 private applicators are registered with the NJDEPE PCP. During each year's survey, application records were requested for growing season one year prior to the survey year.

Funds for this Pesticide Use Survey were provided through a contract from the Division of Science and Research (NJDEPE) and by a grant from USDA CSRS, #90-34050-5055 and the NJDEPE Pesticide Control Program.

Survey Procedures

During the 1986 survey of private applicators the following basic information was requested on the survey:

1. County
2. Address (Municipality, Zip Code)
2. Pesticide name (trade/common)
3. Formulation
4. Amount applied per season
5. Acres treated
6. Crop treated
7. Method of application (either air or ground)

In order to simplify the process, crop codes were developed for nine categories:

1. Tree fruit
2. Smallfruit
3. Vegetable
4. Field crop
5. Nursery
6. Greenhouse
7. Sod
8. Livestock/Poultry
9. Miscellaneous

Survey forms, along with an instructional letter and return envelope, were sent to the over 3,000 registered private applicators in 1986 and 1989. A second mailing, including another survey form, was sent to the non-respondents, indicating that the initial survey had not been returned and that regulatory action would result if the surveys were not returned. A third mailing was sent to the final group of non-respondents. After 30 days, an inspector from the Bureau of Pesticide Compliance within PCP scheduled a visit with the final group of non-respondents.

Follow up investigations were conducted by PCP personnel for approximately 15% of the operations by making phone calls or visiting farms in order to gauge the accuracy of the data that was reported. This quality assurance check included reviews of farm application records, records of purchases, and farm storage checks.

A database was designed using d-Base III Plus (Ashton-Tate). Upon receipt of the survey form by PCP, each was logged in, checked, and entered into the database. Data entered included the applicator's identification number, the municipality farmed, the pesticide name reported, the formulation(s) used on specific crop types, the amount of formulation applied, the number of acres treated with the specific formulation, the crop type, and the application method. Sub-routines in the database identified the active ingredient(s) in the formulation(s) and calculated the number of pounds of active ingredients used. The database entries were verified in a final quality assurance check.

During the 1988 survey the same procedures as were used in 1985 were followed with the exceptions that greenhouse applications were added as a method of application, and that the original crop codes employed in 1985 were expanded to include the following categories:

1. Apples
2. Peaches
3. Other Tree Fruit
4. Blueberries
5. Cranberries
6. Strawberries
7. Grapes
8. Field Corn
9. Soybeans
10. Small Grains
11. Hay
12. Beans (All Types) and Peas
13. Cole Crops (Cabbage, Cauliflower, etc.)
14. Solanaceous (Tomatoes, Peppers, Eggplant)
15. Vine Crops or Cucurbits
16. Leafy Vegetables (Lettuce, Endive, etc.)
17. Potatoes and Sweet Potatoes
18. Sweet Corn
19. Nursery
20. Sod
21. Livestock/Poultry
22. Other not listed

This expansion of crop codes was deemed necessary to better evaluate the use of materials on individual crops for both Extension and PCP purposes.

Results

For this report, all pesticide formulations were converted to their appropriate amount of active ingredient(s).

In 1985, a total of 2,957 replies were obtained, out of 3,117 registered private applicators resulting in a return rate of 95%. For 1988 this same level of return was experienced. Only 130 out of the 3,137 surveys mailed were not returned.

Since there were cases where the applicator was deceased, no longer farming, or more than one registered applicator was affiliated with a specific farm's activities, the final data for each year's survey represents 1,721 and 1,710 separate New Jersey farming operations respectively.

Overall Usage in 1985 and 1988

In 1985, 1,591,346 lbs. of pesticides were reported to be applied (Figure 1), representing over 150 different active ingredients. Of this, the majority of material was applied using traditional ground equipment for each of the different types of pesticide classes. Only a minor portion of all material applied was done via aircraft in 1985. Fungicides ranked number one in in overall use followed by herbicides and insecticides

For 1988, 1,705,651 lbs of pesticides were reported to be applied by either ground, aerial or greenhouse techniques. Of these 1,705,217.4 lbs a.i. were by either ground or aerial methods (Figure 2), representing over 193 different active ingredients. Of this, as in 1985 the majority of material was applied using traditional ground equipment (1,605,138.2 lbs a.i.) for each of the different types of pesticide classes. Only a minor portion of all material was applied using aircraft (100,079.2 lbs a.i.) or greenhouse equipment (433.6 lbs a.i.) in 1988. Fungicides again ranked number one overall in the amount applied by both ground and aerial methods, followed by insecticides and herbicides.

On a countywide basis in 1985, Gloucester County ranked highest in pesticide use with over 300,000 lbs being applied (Figure 3). This was followed by the counties of Burlington and Atlantic with between 200,000 and 300,000 lbs applied, and Cumberland and Salem Counties with between 100,000 to 200,000 lbs applied.

In 1988 the highest amount of pesticides used occurred in Gloucester County with over 400,000 lbs a.i. applied (Figure 4). Cumberland County ranked second in overall use with between 300,000 to 400,000 lbs a.i. applied, followed by Burlington, Atlantic and Salem Counties (200,000 to 300,000 lbs a.i.).

Overall, pesticide usage between 1985 to 1988 increased from 1,591,346 lbs a.i. applied to 1,705,651 lbs a.i., respectively. This increase in poundage represents an increase of 114,295 lbs a.i. or 7%. On a county basis pesticide use declined between 1985 and 1988. In fact, in 10 out of the 20 counties surveyed, usage of pesticide either declined or remained the same between the two years. However, for the major use counties of Atlantic, Burlington, Cumberland, Gloucester and Salem, pesticide use increased in all but Burlington County (-33,899.3 lbs a.i.). Cumberland (+162,586.1 lbs a.i.) and Salem (+90,496 lbs a.i.) Counties experienced the largest increases with a rise of 46.7% and 33.5% respectively. Burlington County also experienced the largest overall drop in usage at -13.8%.

Correspondingly, with this increase between 1985 and 1988 is an overall increase is the use of materials by type of pesticide. There was an increase in 1988 in the application of fungicides, insecticides, fumigants and plant growth regulators over 1985. Herbicide usage, however, dropped from 484,133 lbs a.i. applied in 1985 to 362,385.6 lbs a.i. in 1988. Insecticides showed the greatest increase (141,376.1 lbs a.i.) with a 25.3% rise. Herbicide use declined by 25.1%.

The 12 most applied pesticides overall in 1985 are presented in Figure 5. Of these, sulfur fungicides (363,644 lbs a.i.) ranked as the most used material followed by the EBDC's fungicides (93,735 lbs a.i.), and the herbicides alachlor ((91,576 lbs a.i.) and metolachlor (74,295 lbs a.i.). Overall, as represented by the high use materials, fungicides accounted for 651,980 lbs of material or 41% (Figure 6) of all the pesticides applied, followed by herbicides (30.4%) and insecticides (26.2%).

The 12 most applied pesticides in 1988 are presented in Figure 7. As in 1985, sulfur fungicides (459,141.8 lbs a.i.) ranked as the most used material followed by sodium aluminofluoride (cryolite) at 158,947.2 lbs a.i., the EBDC's fungicides (82,684.2 lbs a.i.), the herbicide metolachlor (69,941.6 lbs a.i.) and dormant oils (67,666.5 lbs a.i.). Overall, fungicides accounted for 736,483.5 lbs a.i. of material or 43.2% (Figure 6) of all the pesticides applied, followed by insecticides (32.82%, 558,699.2 lbs) and herbicides (21.2%, 362,385.6 lbs a.i.).

Three crop groupings, tree fruits (37% - 593.798 lbs a.i.), field crops (24% - 377,690 lbs a.i.) and vegetables (24% - 373,389 lbs a.i.), accounted for 85% of the pesticides applied (Figure 8). The majority of the remaining 15% of material applied was to small fruits (10% - 160,688 lbs a.i.). Direct comparison of total acres treated for each crop category was not possible since multiple applications of various pesticides may be conducted on the same acreage over a single growing season.

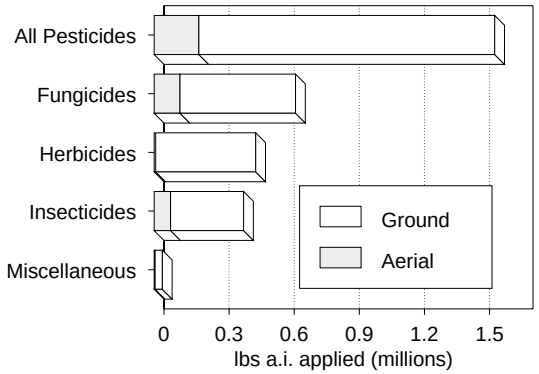


Figure1. Pesticide use by type of application, 1985.

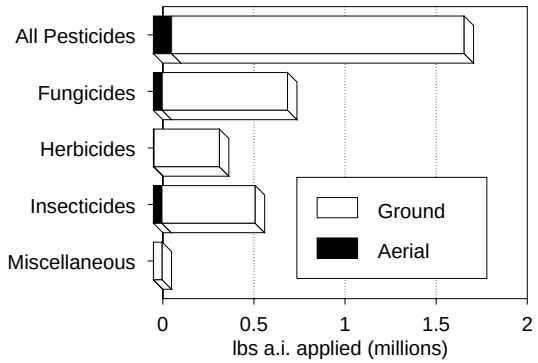


Figure2. Pesticide use by type of application, 1988.

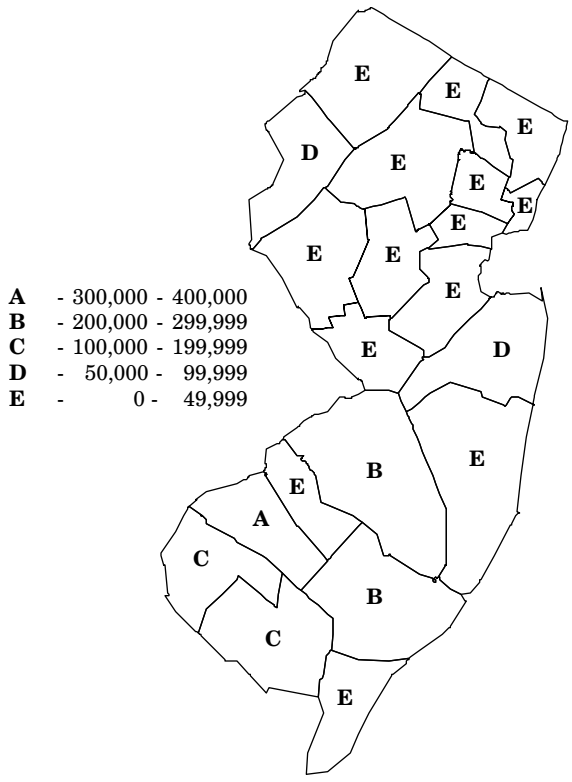


Figure3. Pesticide use by county, 1985.

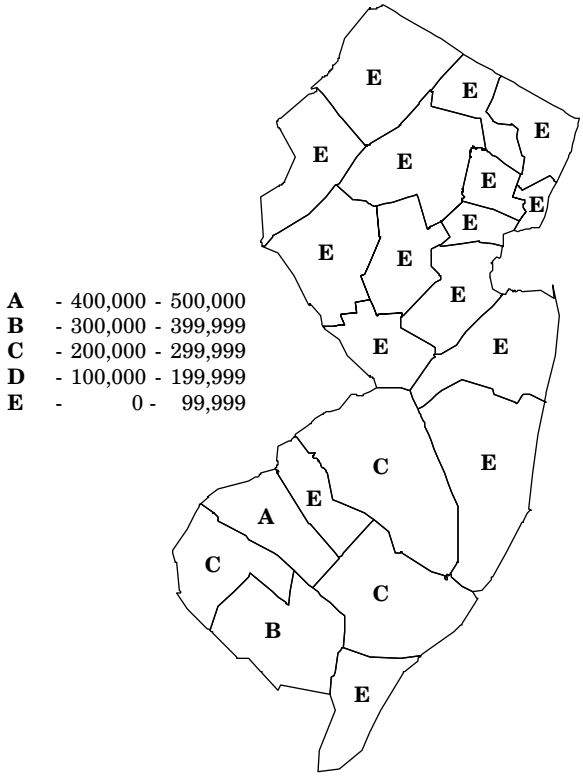


Figure4. Pesticide use by county, 1988.

In 1988, tree fruits (43.6% - 786,819.7 lbs a.i.), vegetables (29.3% - 529,195.6 lbs a.i.), and field crops (14.8 - 267,516.6 lbs a.i.) accounted for over 87% of the pesticides applied. The remaining 13% of the material applied during 1988 was primarily to small fruits (4.5%) and nursery crops (4.5%).

Pesticide Use by Type of Pesticide

The major herbicides for 1985 and 1988 based on the amount of active ingredient applied to all crops are listed in Figure 9. Alachlor, metolachlor, atrazine, butylate, linuron, cyanazine were the most frequently reported compounds in 1985. These six compounds represent 73% (353,417 lbs a.i.) of the herbicides reported.

For 1988, based on the amount of active ingredient applied to all crops, metolachlor (69,941.6 lbs a.i.), diethatyl ethyl (47,677.4 lbs a.i.), alachlor 37,022.6 lbs a.i.), linuron (20,683.9 lbs a.i.), chlorthal dimethyl (20,372.5 lbs a.i.) and atrazine (19,511 lbs a.i.) were the most frequently reported compounds. These six compounds represent 59% of the herbicides reported. The remaining major materials used (above 7,000 lbs a.i.) included cyanazine, 2,4-D, terbacil, paraquat, bensulide and diuron.

Herbicide use between the two years also changed in the relative use of various materials. In 1985, alachlor had the highest overall usage followed by metolachlor, atrazine, and butylate. In 1988 this pattern changed. Metolachlor replaced alachlor as the number one material applied but remained second in overall use. This reversal may be due, in part, to groundwater concerns regarding alachlor and its designation as a restricted use material by both the NJDEPE and the Environmental Protection Agency (EPA). Atrazine dropped to fourth overall with diethatyl ethyl increasing to third. Butylate use experienced the greatest drop in use while diethatyl ethyl exhibited the greatest increase.

Major insecticides based on the amount of active ingredient applied to all crops are listed in Figure 10. Parathion (30,115 lbs a.i.) and dormant oil (42,615 lbs a.i.) were most frequently applied in 1985 followed by methomyl (31,197 lbs a.i.), endosulfan (28,973 lbs a.i.), oxamyl (18,303 lbs a.i.), carbofuran (15,385 lbs a.i.), azinphos-methyl (11,222 lbs a.i.) and carbaryl (10,721 lbs a.i.). All but carbofuran are used for multiple applications to fruit and vegetable crops. This group of compounds made up over 70% (292,126 lbs a.i.) of insecticides reported.

The major insecticides used in 1988 included cryolite (158,947.2 lbs a.i.) and dormant oil (67,666.5 lbs a.i.) as the most frequently applied, followed by methamidophos (43,816.8 lbs a.i.), parathion (30,783.6 lbs a.i.), carbofuran (29,783.7 lbs a.i.) and azinphos-methyl (26,034.1 lbs a.i.). This group of compounds made up over 63% (357,031.9 lbs a.i.) of insecticides reported. In addition to the above compounds, methomyl, endosulfan, permethrin, carbaryl, dimethoate and acephate all had reported use rates above 15,000 lbs a.i.

Insecticides showed similar types of changes in use patterns. Overall, sodium aluminofluoride (cryolite) was by far the most used material and showed the largest increase in use between the two years. This increase, however, is due to the issuance of a Section 18 label for Colorado potato beetle control in potatoes which was not in effect in 1985. In 1985, parathion had the highest use followed by dormant oil, methomyl and endosulfan. In 1988, if cryolite is dropped from the use pattern, dormant oil switches with parathion as the number one used, followed by methamidophos, and carbofuran. Excluding cryolite, methamidophos showed the greatest increase while endosulfan had the greatest decrease in use.

In 1985 sulfur was, by far, the most reported compound in the survey, representing nearly one quarter (23%) of the overall material and over half (56%) of the fungicides applied. Other major fungicides based on the amount of active ingredient applied to all crops are listed in Figure 11. High use compounds also included captan, the ethylene bisdithiocarbamates (EBDC's: mancozeb, maneb, zineb, and metiram), ferbam, and chlorothalonil. Over 90% of the reported fungicides are represented by the above noted compounds.

As in 1985, elemental sulfur was the most reported compound in the 1988 survey, representing over one quarter (26.9%) of the overall material and just under two thirds (62.3%) of the fungicides applied. Other major fungicides based on the amount of active ingredient applied to all crops are listed in Figure 12A and include the EBDC's (82,684.2), captan (63,880.4), chlorothalonil (37,122.9), ferbam (29,160.9) and quintozene (10,393.9). Other fungicides with use patterns above 5,000 lbs a.i. include metalaxyl, benomyl and captafol.

For both years, elemental sulfur ranked number one in total use for fungicides . In fact, sulfur use showed the greatest overall increase between years. This may be due to label changes and concerns regarding both EBDC's and captan. with the exception of elemental sulfur, the overall use pattern for the additional fungicides applied remained fairly consistent between 1985 and 1988. While EBDC use and captafol use dropped in 1988, all but captafol exhibited expanded usage. EBDC's, captan, chlorothalonil and ferbam ranked second, third, fourth, and five, respectively, for both years.

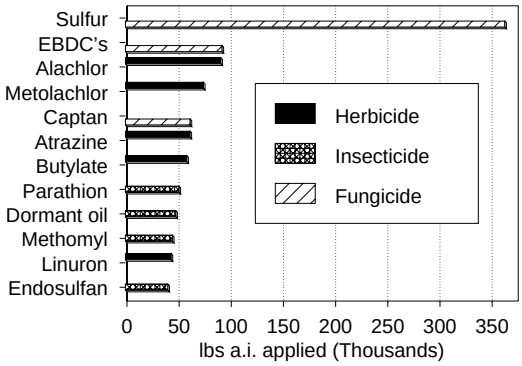


Figure5. Most commonly applied pesticides, 1985.

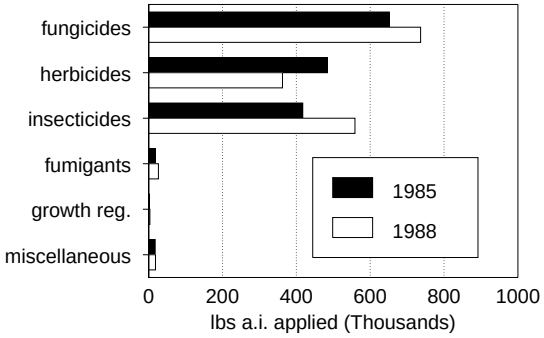


Figure6. Pesticide use by type of material, 1985 and 1988.

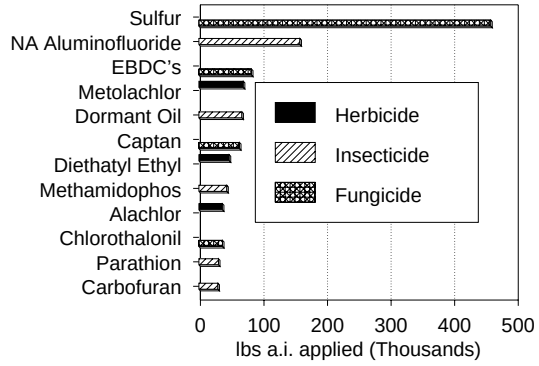


Figure7. Most commonly applied pesticides, 1988.

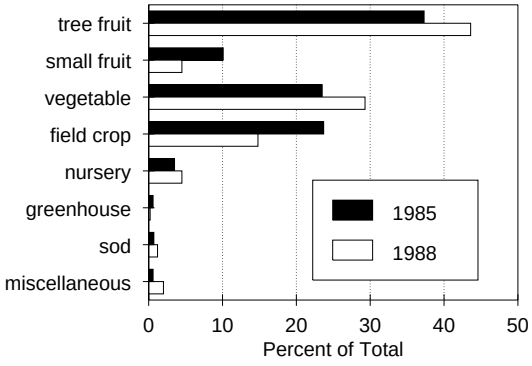


Figure8. Pesticide use by crop, 1985 and 1988.

All other active ingredients reported in the 1985 survey (figures 12-14) represented 2% of all compounds applied with fumigants making up approximately 1% of the total. Metam sodium (13,087 lbs a.i., represented 71% of the fumigants applied.

For 1988, fumigants, plant growth regulators and miscellaneous ingredients reported in the survey represented 2.7% of all compounds applied with fumigants accounting for 1.5% of the total use. Within this group, fumigants also made up 58.5% of the total. Metam Sodium (10,564.1 lbs a.i.) represented 40% of the fumigants applied. Other fumigants used included methyl bromide, fenamiphos and methyl isothiocyanate.

Fumigants showed an increase in use over 1985. This change was based mainly on a significant expansion in the use of methyl isothiocyanate. Metam sodium and methyl bromide were also major materials in 1988 but showed decreases in use from 1985 as did dichloropropene. This later pesticide also showed the largest drop in use between years.

In 1985 the synergist piperonyl butoxide (14,734 lbs a.i.) was applied primarily to vegetable crops. Other miscellaneous compounds are listed in Figure 14.

Daminozide was the most used plant growth regulator (1,782.8 lbs a.i., Figure 13) applied in 1988 followed by ethephon (1,272 lbs a.i.), chlormequat chloride (169.2 lbs a.i.) and gibberellin (17.5 lbs a.i.) The synergist piperonyl butoxide (PBO) (5,308 lbs a.i., Figure 14) accounted for 28.7% of the usage in the miscellaneous category. Its was applied primarily in vegetable crops.

The overall use of plant growth regulators increased between 1985 and 1988. However, for individual materials the patterns were primarily unchanged. In 1985, daminozide and ethephon were the most used materials followed by NAA/NAD and chlormequat chloride. In 1988, the only change in this pattern is the switch between NAA/NAD and chlormequat chloride. In fact, the use of NAA/NAD dropped dramatically in 1988. Daminozide, ethephon and chlormequat chloride all exhibited substantial increases in use in 1988 with ethephon showing the largest increase.

For the miscellaneous category, the five top chemicals were the same for both years but their rankings changed. PBO ranked number one both years with a large increase in use in 1988. Calcium chloride moved from fourth to second while oxatetracycline moved from second place to third. For both years boric acid ranked fifth, however, streptomycin dropped from third to fourth. There was also a marked increase in the all other category between 1985 and 1988 which may explain the drop in some of the five major materials.

Pesticide Use by Crop

Of the 377,690 lbs a.i. of pesticides applied to field crops in 1985, 89% of the chemicals used were herbicides (Figure 15), followed by insecticides at 8% and fungicides at 2%. Within this use pattern, alachlor and metolachlor were by far the most used materials. These herbicides accounted for 38% of the overall use in field crops.

For 1988 the 267,547 lbs a.i. of pesticides applied to field crops, 91% were herbicides. Of all the herbicides applied, metolachlor represented the highest use level. This herbicide accounted for 20% of the overall use in field crops. Alachlor (9%), linuron (7%), atrazine (6%), cyanazine (6%) and paraquat (2%) also had significant use patterns for herbicides while carbofuran (6%) was the only insecticide constituting a major use. The highest use occurred in field corn (150,162 lbs a.i.) with soybeans second at 125,115 lbs a.i. For each crop, as expected, herbicides were the major class of pesticide used. For field corn, atrazine had the greatest use level (29%) followed by metolachlor (25%). In small grains, 71% of the pesticides applied were formulations of the herbicide 2,4-D, followed by dicamba at 18%. In soybeans, metolachlor accounted for 38% of the usage with alachlor second at 22% followed by linuron at 22%.

For small fruits (160,688 lbs) fungicides had the highest usage (55%) followed by insecticides (27%), and herbicides (18%) in 1985 (Figure 16). The most used material in small fruits was elemental sulfur (22% of the total usage) followed by ferbam (12%) and captan (10%). All three of these materials are fungicides.

In 1988 (81,562 lbs a.i.), insecticides had the highest usage (52%) followed by herbicides (31%), and fungicides (18%) in small fruits. The most used material in small fruits was captan at 23% followed by azinphos-methyl (11%) and chlorothalonil (9%). Ferbam (8%), parathion (5%), captafol (5%) and norflurazon (4%) also had high usage. Within this group, blueberries had the highest use at 47,262 lbs a.i. with fungicides (49%) accounting for the most applied type of pesticide. Insecticides ranked second and fungicides third. For individual pesticides applied, captan had the greatest use at 33% of the all materials applied followed by azinphos-methyl (13%). The crop with the second highest overall use was grapes (27,150 lbs a.i.). Fungicides (61%) were the most used materials with chlorothalonil and ferbam explaining for 47% of the total usage.

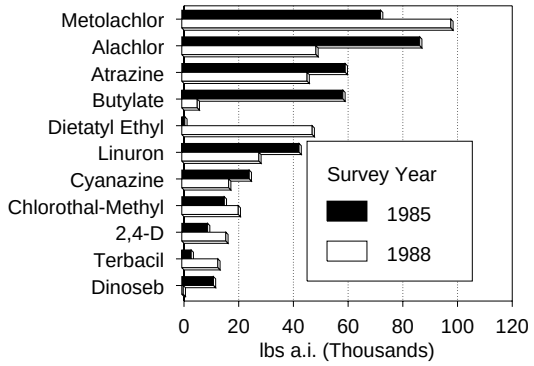


Figure 9. Highest use pesticides - Herbicides, 1985 and 1988.

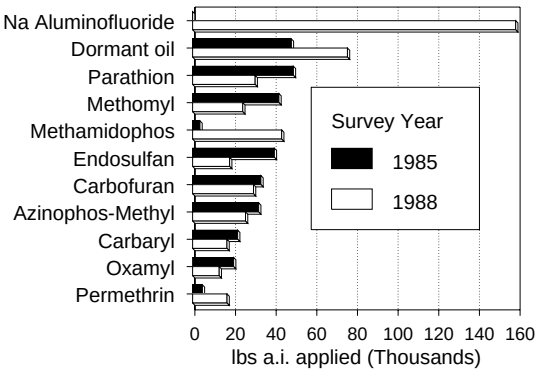


Figure 10. Highest use pesticides - Insecticides, 1985 and 1988.

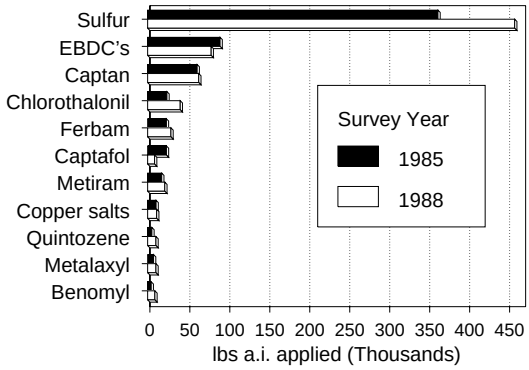


Figure 11. Highest use pesticides - Fungicides, 1985 and 1988.

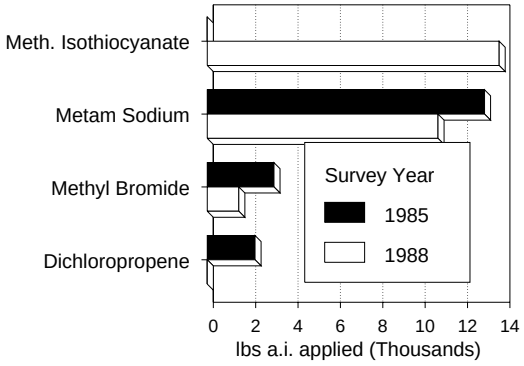


Figure 12. Highest use pesticides - Fumigants, 1985 and 1988.

In tree fruit for 1985, as with small fruits, the greatest used type of pesticide was also fungicides (Figure 17). Fungicides accounted for 79% of the pesticides used, followed by insecticides at 22%. The material used in the greatest amount was elemental sulfur (59%).

As in 1985, the most used type of pesticide on tree fruit in 1988 was fungicides. Fungicides accounted for 62% of the pesticides used, followed by insecticides at 22%. The material used in the greatest amount was elemental sulfur (59%) followed by dormant oil (8%) and captan (5%). Of all tree fruits, peaches ranked number one (536,893 lbs a.i.,) in the amount of material applied. Behind peaches, apples was second at 254,960 lbs a.i. of pesticides. For both peaches and apples, fungicides were the most used pesticides with most of the use being elemental sulfur (75% and 19% respectively). Dormant oil ranked number two for apples, while in peaches ferbam and captan ranked second. For all other tree fruit, which includes plums, pears, etc., insecticides had the highest use with dormant oil having the highest level (38%).

The usage in vegetables was different from field crops, small fruit and tree fruit. Insecticides were the most used type of material in vegetables in 1985 (Figure 18). This pesticide group accounted for 48% of the usage, with fungicides being second at 29% and herbicides third at 19%. The highest used materials reflect this pattern as well. For the seven materials used the most (4% to 12%), five were insecticides (29%) and two fungicides (20%).

The overall usage in vegetables was different from field crops, and tree fruit but similar to small fruits in 1988. Insecticides were the most used type of material in vegetables. This group accounted for 55% of the usage, with herbicides second at 23% and fungicides third at 15%. The highest used materials reflect this pattern as well. For the four materials used the most (4% to 30%), sodium aluminofluoride (cryolite) accounted for 30% with diethatyl ethyl explaining 9% and 2 fungicides, EBDC's and chlorothalonil (5% and 4%, respectively) representing 9% of the overall use. For individual vegetable crops potato, leafy vegetables and solanaceous crops had the greatest usage (216,197 lbs a.i., 96,219 lbs a.i. and 81,538 lbs a.i., respectively). For potato, insecticides recorded the largest amount applied with cryolite comprising 74% of the use. In leafy vegetables, herbicides ranked number one (56,769.2 lbs a.i.) with diethatyl ethyl with 55% of the total use. For solanaceous crops, insecticides (40%) were second to fungicides (44%) with EBDC's accounting for 15,492 lbs a.i. applied. For the other crop categories, insecticides were used the most in beans, cole crops and sweet corn. In vine crops, however, fungicides had the highest level of use.

The use differences between 1985 and 1988 for field crops, small, tree fruit and vegetables were varied. Overall, the use pesticides decreased in both field crops (-29%) and small fruit (-49%) but increased in tree fruit (25%) and vegetables (29%). The use patterns for each, however, while changing in percentage-wise remained basically the same. For field crops, small fruit and tree fruit the pattern remained identical between years with usage in each class of pesticide increasing slightly. Herbicides were the major class applied in field crops both years while in small fruits and tree fruits fungicides were the most applied. In vegetables, fungicides and insecticides ranked one and two, respectively. However, in 1988 insecticides ranked number one and herbicides number two.

The usage patterns for greenhouses, nursery, sod and miscellaneous uses for 1985 and 1988 are presented in Figures 19-21. Insecticides accounted for the majority of the pesticides applied in both greenhouses and nurseries (49% and 44%, respectively) in 1985. However, for sod (88%) and miscellaneous uses (55%), herbicides were the most commonly applied materials. The highest used insecticides in all four categories included nicotine, carbaryl, diazinon and acephate. Simazine, chlorthal methyl, alachlor and linuron represented the most used herbicides. For fungicides, benomyl, EBDC's, chlorothalonil had the greatest usage.

In 1988, herbicides accounted for the majority of the pesticides applied in both sod and miscellaneous categories (63% and 37%, respectively). However, for greenhouses fungicides (76%) ranked number one while for nurseries insecticides (38%) were most applied. In this latter group, fungicides ranked a close second at 37%). The highest used insecticides in all four categories included dormant oil, fenamiphos, oxamyl acephate. 2,4-D, chlorthal dimethyl and dicamba represented the most used herbicides. For fungicides, captafol, copper sulfate and EBDC's had the greatest usage.

The use of pesticides also increased for the nursery, sod and miscellaneous categories. For nursery crops insecticides were the most applied in both years followed by herbicides in 1985 and fungicides in 1988. Herbicides were the most applied materials to sod in both years followed by insecticides and fungicides. Herbicides were also the most applied materials each year in the miscellaneous category. Fungicides ranked second both years and insecticides third.

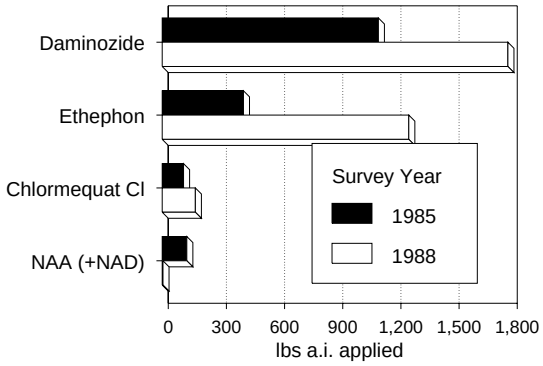


Figure 13. Highest use pesticides - Plant Growth Regulators, 1985 and 1988.

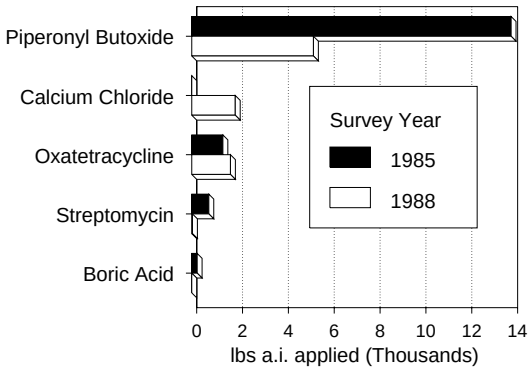


Figure 14. Highest use pesticides - Miscellaneous Chemicals, 1985 and 1988.

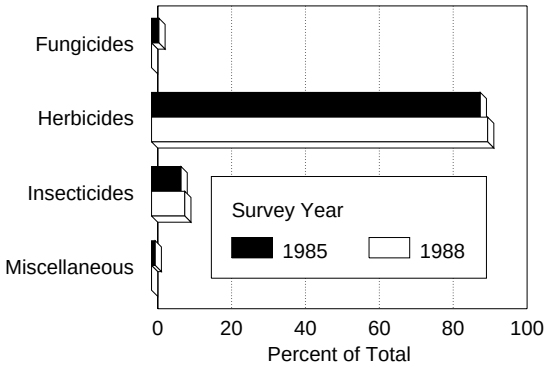


Figure 15. Pesticide use in field crops, 1985 and 1988.

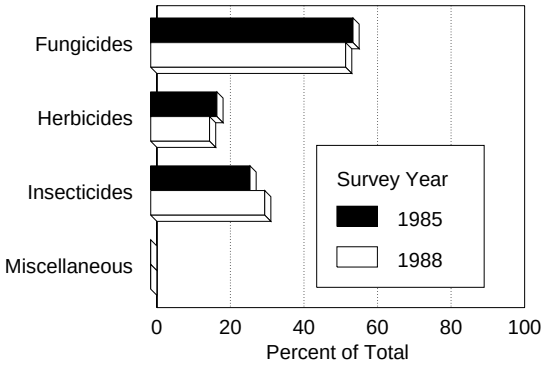


Figure 16. Pesticide use in small fruits, 1985 and 1988.

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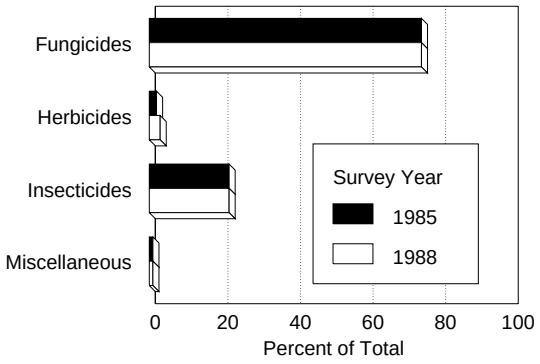

Figure 17. Pesticide use in tree fruit, 1985 and 1988.

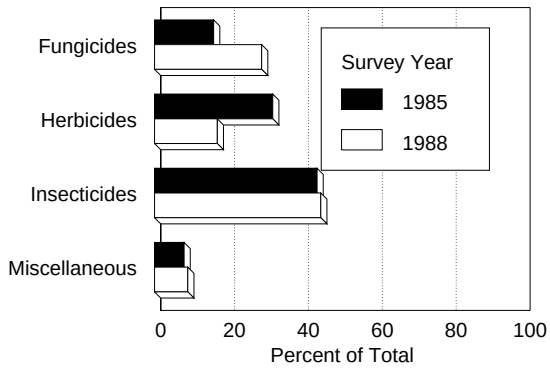

Figure 18. Pesticide use in vegetable crops, 1985 and 1988.

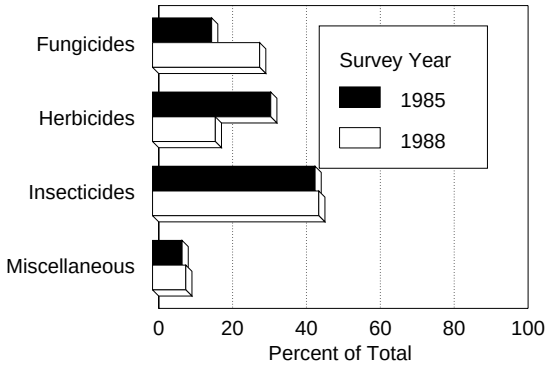

Figure 19. Pesticide use in nursery crops, 1985 and 1988.

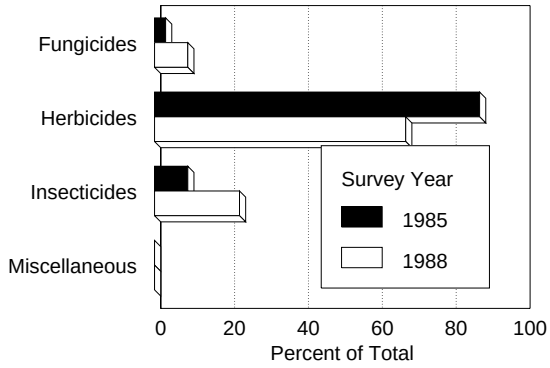

Figure 20. Pesticide use in sod, 1985 and 1988.

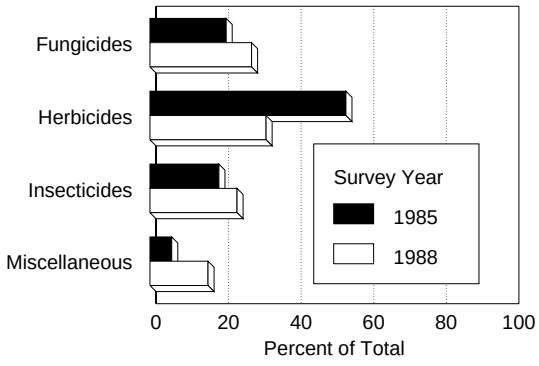

Figure 21. Pesticide use in miscellaneous crops, 1985 and 1988.