Long-term Insecticide Use Found to Result in Neurologic Effects

The following is a summary of a recent research publication entitled *Neurologic Symptoms in Licensed Private Pesticide Applicators in the Agricultural Health Study* by Freya Kamel, Lawrence S. Engel, Beth C. Gladen, Jane A. Hoppin, Michael C.R. Alavanja, and Dale P. Sandler. The authors are scientists with the National Institutes of Health and the National Institute of Environmental Health Sciences. The entire publication can be obtained at http://ehp.niehs.nih.gov/members/2005/7645/7645.pdf.

Lack of proper nervous system function is the best documented health effect of pesticide exposure. High-level exposure has both acute and long-term neurologic effects, and adverse effects have been reported for most types of pesticides, including organophosphate, carbamate, organochlorine, and pyrethroid insecticides; herbicides; fungicides; and fumigants. Organophosphates have been studied in greatest detail. Acute organophosphate poisoning can involve a wide range of both central and peripheral neurologic symptoms. Effects of organophosphate poisoning may persist long after acute effects cease. These effects include increased neurologic symptoms, reduced neurobehavioral performance, decreased vibration sensitivity, and reduced nerve function. Effects continue up to 10 years after poisoning, suggesting permanent damage.

Even less severe poisoning can have long-term effects. Questions remain concerning the neurologic effects of moderate pesticide exposure. Most studies show effects on thinking and thought response in chronically exposed individuals without a history of poisoning, although peripheral nerve function like vibration sensitivity and nerve conduction are not generally affected. Increases in both central and peripheral neurologic symptoms are also found in many studies of moderate exposure. Increased symptoms may indicate early loss of nervous function, before measurable signs appear. Unknown factors in the relationship of pesticide exposure to symptoms include the relative importance of acute and chronic exposure, of pesticide poisoning or high-exposure events compared to chronic moderate exposure, and of pesticides other than organophosphates.

The Agricultural Health Study is a large-cohort study of licensed pesticide applicators and their spouses that began in 1993 with about 52,400 private applicators (mostly farmers) from Iowa and North Carolina participating; 82% of those continued in the study. At enrollment, participants completed a self-administered questionnaire that collected information on demographic characteristics, lifestyle, medical history, and pesticide use. A supplemental questionnaire, completed at home by 44% of the enrolled private applicators, collected additional information in these categories, as well as information on neurologic symptoms. Together, the two questionnaires collected information on frequency and duration of use, including affect, cognition, autonomic function, motor function, and vision. Questionnaires completed by applicators provided information on neurologic symptoms during the prior year, as well as detailed information on lifetime pesticide use and...
exposure. This was used to analyze the relationship of symptoms to several measures of pesticide exposure.

This study found that increased neurological symptoms were associated with increased cumulative lifetime use of pesticides, particularly insecticides and fumigants, even without a history of pesticide poisoning or events involving high personal pesticide exposure.

Most previous studies of pesticides and neurologic symptoms have focused on organophosphates. Farm workers, greenhouse workers, and factory workers exposed to organophosphates reported more symptoms than unexposed workers. Farmers and farm workers who applied organophosphates had more neurologic symptoms than nonapplicators, as did commercial termiteicide applicators. Other studies have found higher levels of tension, anxiety, anger, and depression in workers exposed to organophosphates. Most studies found increased symptoms associated with inhibition of erythrocyte acetylcholinesterase activity, a biomarker of recent organophosphate exposure.

Although poisoning by high exposures to organochlorines, fungicides, and fumigants, as well as organophosphates, is well documented, and carbamates, pyrethroids, and herbicides are also neurotoxic, questions remain concerning the effects of moderate exposure to pesticides other than organophosphates. One study of moderate exposure found that DDT was associated with an increased likelihood of neurologic symptoms, as did one study of fumigants although that result was not found in another fumigant study.

The relative neurotoxicity of specific chemicals or chemical classes may differ for acute high-level and chronic moderate exposure. Few previous studies were able to distinguish between effects of acute and chronic exposure because the two are often correlated. Two studies with sufficient information to make the distinction found that in farm workers who applied pesticides, those with neurologic symptoms were associated with acute but not chronic exposure. In contrast, this study’s results suggest that moderate levels of cumulative lifetime exposure increase the likelihood of having neurologic symptoms rather than exposure during the year prior to reporting symptoms. This may be due to the higher level of exposure experienced by farm workers, compared to licensed applicators.

The role of pesticide poisoning in the apparent effects of cumulative use is still a question. This study confirmed previous reports that a history of pesticide poisoning is associated with an increased likelihood of neurologic symptoms. A notable finding in this study is that a history of high personal pesticide exposure conferred equally great risk, even without diagnosed poisoning. Some studies have not differentiated exposed individuals with a history of pesticide poisoning from those without.

Two studies that excluded poisoned individuals found no relationship of moderate organophosphate exposure to the likelihood of poisoning symptoms although a study of DDT that excluded poisoned individuals did find an association. This study found that neurologic symptoms were more likely with increased long-term exposure to all insecticides, organophosphates, and organochlorines whether or not the persons had previously experienced acute pesticide poisoning or high-exposure events, indicating that moderate exposure itself is associated with increased risk.

These results agree with previous studies suggesting that moderate pesticide exposure is associated with a wide range of symptoms, reflecting cognitive, sensory, and motor dysfunction and affecting both the central and peripheral nervous systems. Younger, rather than older, applicators reported more of these poisoning symptoms. This may be due to the younger participants’ understanding of the symptom questions or their reporting tendencies rather than being a real effect. Perhaps those that experienced pesticide poisoning symptoms left farming at an early age and thus were not interviewed as older farmers. Younger applicators used more pesticides in the year prior to enrollment, the period for which symptom occurrence was reported; however, adjusting for recent use did not affect the likelihood of symptoms associated with cumulative use. In any case, because symptom prevalence decreased and cumulative exposure increased with age, age or age-related conditions like heart disease or diabetes cannot explain the likelihood of neurologic symptoms observed with cumulative exposure. In fact, excluding individuals with the age-related conditions did not affect the results. This point is particularly important in interpreting results for organochlorine pesticides. Recent trends in use mean that older applicators are more likely to have used these chemicals, but this cannot account for the results because younger applicators also report more likely to report neurologic symptoms. Adjustments were made for other potential confounders, including education, so these are also unlikely to account for the results.

Because symptoms were self-reported, another concern is potential recall or reporting bias. However, the fact that only some pesticides were associated with symptoms suggests that recall bias does not account for the findings. Further, risks associated with insecticide exposure were dose-related. Moreover, the findings of this study are biologically plausible, as the greatest risk of neurologic effects were for insecticides, which are designed to be neurotoxicants. An important strength of the study is its large size. Also, because farming practices are considerably different in Iowa and North Carolina, the study represents a diverse farming population.

In conclusion, the study found that the prevalence of neurologic symptoms was associated with cumulative lifetime exposure to pesticides, particularly organophosphate and organochlorine insecticides and fumigants. These associations were present in individuals with no history of pesticide poisoning or high-exposure
More Pesticide Dealers May Need to Register

For many years, the Illinois Pesticide Act (415 ILCS 60/13) has required any pesticide dealer who sells restricted-use pesticides to be registered with the Illinois Department of Agriculture. Illinois House Bill #0295, introduced in January 2005, seeks to expand this requirement to include pesticide dealers who sell nonrestricted-use pesticides (for use in the production of an agricultural commodity) in containers with a capacity of 2.5 gallons or greater or 10 pounds or greater. This bill passed unanimously in the House and was sent to the Senate in February. The Senate Agriculture and Conservation Committee amended the bill to ensure that each place of business (as opposed to a company’s headquarters) will be considered a separate entity for the purpose of registration.

When will this take effect?

As of May 4, 2005, the bill (as amended) is scheduled to be presented to the Senate for a third reading and a vote. Because the Senate amended a House bill, it must then go back to the House for a concurrence vote. If the bill (as amended) passes both House and Senate in its current state, it is scheduled to take effect July 1, 2005.

If the bill becomes law …

1. If you need to become a registered/licensed dealer, you will need to pass the Dealer exam that is administered by the Department of Agriculture (IDOIA). The annual license fee is $100. The license expires on December 31 of each year, and you must retest every 3 years. If you hold and maintain a Structural Pest Control license with the Illinois Department of Public Health or a Commercial Applicator’s license with the IDOA, you are exempt from the Dealer exam and license fee, but you must still register as a Dealer with the IDOA each year.

2. To prepare for the Dealer exam, you should study the Illinois Pesticide Applicator Training Manual 39-14: Pesticide Dealer, which is available (for $8) from your local University of Illinois Extension office or by calling 800-644-2123. The Dealer exam is based on this manual, which includes the following chapters: Labels and Labeling; Illinois Pesticide Act; Agrichemical Facilities Act; and the Lawn Care Products Application and Notice Act.

3. Finally, recognize that if you deal with large containers of pesticides (that is, single containers in excess of 300 gallons or 300 pounds), you may also need to comply with agrichemical containment rules (IL Administrative Code Title 8, Part 255). You can learn more about these rules at http://www.ilga.gov/commission/jcar/admincode/008/00800255sections.html.


Illinois Aerial Applicators Ready for Action

The Illinois Agricultural Aviation Association’s 2005 Operation S.A.F.E. fly-in clinic was April 25 to 27 at the Coles County Memorial Airport near Mattoon. The event was sponsored by Syngenta, which also provided volunteers to run the flight line and collect data. Just like the fly-in last year, the event was a success.

S.A.F.E., which stands for Self-Regulating Application and Flight Efficiency, is a program designed to help aerial applicators set up their aircraft to make safe and accurate applications. The heart of the program is the S.A.F.E. fly-in analysis clinic. At a fly-in, pilots can have their aircraft professionally analyzed for pattern uniformity and droplet size. Trained S.A.F.E. analysts interpret the results of the tests and recommend changes to improve aircraft performance. Pilots can then do an immediate follow-up test to make sure it is set up correctly. S.A.F.E. analysts are dedicated to improving application accuracy and reducing the risk of spray drift. See Illinois Pesticide Review, vol. 17, no. 3, May 2004, for more details about Operation S.A.F.E. fly-ins.

This year, aerial applicators in Illinois are preparing for the potential threats of soybean rust and soybean aphids. Creating the correct droplet size is important for controlling both of these pests, especially soybean rust, which requires thorough coverage and good canopy penetration. Many of the aerial applicators at the Illinois fly-in were adjusting their nozzles to create the right droplet spectrum for these applications.

Nozzle selection and setup are just as important for aerial applications as they are for ground applications. The nature of the spraying platform, however, changes the strategy. For aerial applications, droplet size is controlled by the nozzle type, orifice size, operating pressure, and angle of deflection or nozzle. The two main types of nozzles used by aerial applicators in Illinois are flat-fans and what are commonly called CP nozzles. Flat-fans used for aerial applications typically have either 40- or 80-degree fan angles and flow rates up to around 3.5 gallons per minute. The orientation of flat-fan nozzles on the boom can be adjusted to change the angle at which the spray enters the high-speed air.

CP nozzles are designed specifically for aerial applicators and have two adjustable pieces. The first piece is a plate with multi-
ple orifices. The applicator uses a knob to select which orifice matches up with the nozzle outlet, allowing the applicator to quickly change flow rates without changing nozzles. The second part allows the applicator to select different angles of deflection, which changes the angle at which the spray leaves the nozzle and enters the high-speed air caused by the airplanes flight.

Changing the angle at which the spray enters the high-speed air caused by the flight of the aircraft is important because that high-speed air is the primary factor influencing droplet size for an aerial application. As the spray leaves the nozzle, it is subjected to a shearing effect caused by the high-speed air. The amount of shearing determines droplet size, with more shear creating smaller droplets and less shear creating larger droplets. By changing the degree of shearing on the spray, droplet size can be controlled. Because initially large droplets present a larger target to the air shear, they are fragmented to a greater degree than smaller droplets and result in a finer droplet spectrum.

Changing the pressure initially influences the droplet size in the same manner as with ground applications. Low pressures generate larger droplets. These larger droplets, however, are subjected to greater air shear, are therefore fragmented, and result in finer droplets. By increasing the pressure, two things happen. First, the initial droplet size is smaller. Second, the higher pressure means the spray enters the air at a speed closer to that of the air flow. These two factors reduce the shearing effect on the droplets and actually increase the droplet size created. Changing the nozzle angle also changes the influence of the air shearing. By increasing the angle at which the spray enters the air flow, either by reorienting the angle of a flat-fan nozzle on the boom or selecting a different deflector angle on a CP nozzle, air shear is increased and droplet size is reduced. By decreasing the angle and reducing air shear, droplet size is increased.

Extensive research done by the USDA Agricultural Research Service in College Station, Texas, using a wind tunnel examined these relationships. The research led to the development of models that aerial applicators can use to help them set up their aircraft. These models are Excel spreadsheets available for download at http://apmru.usda.gov/downloads/downloads.htm. Clicking on the “AERIAL SPRAY NOZZLE MODELS (Technical Version) 2005 (Excel Spreadsheet)” link leads to a list of models, and the applicator can then select the model based on the type of nozzle being used. The applicator can enter orifice size, pressure, angle, and aircraft speed. The model then calculates the volume median diameter, as well as several other droplet size statistics, and graphs the entire droplet spectrum in relation to the reference nozzle droplet spectrums used to classify nozzles in the American Society of Agricultural Engineers (ASAE) standard S-572: “Spray Nozzle Classification by Droplet Spectra.” By changing the values on these spreadsheets, the applicator can examine what happens to the droplet size and correctly setup the aircraft for the type of application being made. At the fly-in, the droplet size can be verified using analysis of water-sensitive paper laid on the flight line. Adjustments to the nozzle angle can be made on site and results verified immediately.

Aerial applicators also can view their spray pattern using results from the analysis of the string collected on the flight line, and adjustments can be made to nozzle placement to correct any problems with the pattern. They can also determine the best height at which their aircraft should be flown to provide the most uniform spray pattern. Flying too low can actually increase drift and reduce deposition for aerial applicators. An ideal height for aircraft to fly is often between 10 and 14 feet above the canopy. Any higher and the droplets are excessively exposed to wind. At lower heights, droplets can become trapped and carried off in air turbulence caused by the aircraft flying so close to the crop canopy.

Following the Operation S.A.F.E. fly-in, aerial applicators in Illinois are ready to spray for this coming season. By correctly setting up their aircraft, they can be assured they will be making applications that are both effective and safe. (Scott Bretthauer)

**Six Pest Management Handbooks Available**

Whether you’re trying to manage pests in your back yard, in your back 40, or for your commercial contracts, University of Illinois Extension has a pest management handbook for you. The following six publications contain suggestions for the management of weed, disease, and insect pests for a wide range of crops and ornamental plants. This information can help you keep current regarding chemical and non-chemical pest management strategies, as well as management timing, regulatory, and safety issues.

The 2004 Home, Yard & Garden Pest Guide (C1391, $24.00, 179 pages) contains chemical and nonchemical suggestions for homeowners and other residents to control pests associated with trees, shrubs, turf, flowers, groundcovers, vegetables, fruit, and houses. In addition, you’ll find detailed information about integrated pest management, pesticide safety, and pesticide application and calibration techniques.

The 2005 Commercial Landscape and Turfgrass Pest Management Handbook (ICLT-05, $15.00, 110 pages) addresses insect, weed, and disease pests associated with turf, trees, shrubs, flowers, and groundcovers, with professional suggestions for control provided.
The following information provides registration status of particular pesticides and should not be considered as pesticide recommendations by University of Illinois Extension.

**Agronomic**

Folicur 3.6F (tebuconazole)—Bayer Crop Science—A Section 18 label was granted by the U.S. EPA on April 29, 2005, for use on wheat in Illinois to manage Fusarium head blight (scab). (Source: The Bulletin, no. 7, May 6, 2005)

Headline SBR (pyraclostrobin + tebuconazole)—BASF—Received approval under Section 18 for use on soybeans to help control soybean rust. (Source: e-mail from IDA, 4-27-05)

Orius 3.6F (tebuconazol)—Makhteshim Agan—Received approval under Section 18 for use on soybeans to help control soybean rust. (Source: e-mail from IDA, 4-27-05)

PROQUINAZID—DuPont—A new fungicide being developed to control powdery mildew in cereals.

Quilt (azoxystrobin + propiconazole)—Syngenta Crop Protection—Received approval under Section 18 for use on soybeans to help control soybean rust. (Source: e-mail from IDA, 4-27-05)

**Turf/Ornamental**

26 GT (iprodione)—Bayer Environmental Science—Added to their label the control of curvulia and anthracnose on turf.

AKAKI (fenpyroximate)—Nichimo America—Added to their label the use on outdoor ornamentals and non bearing fruit trees. [insecticide]

ALLECTUS (imidacloprid/bifenthrin)—Bayer Environmental Science—EPA has approved this new combination product for use on turf to control belowground and surface-feeding insects. It will be marketed by Bayer and FMC.

ARIA (flonicamid)—FMC—Received EPA registration to use on greenhouse ornamentals to control sucking insects.

CELERO (clothanadan)—Arvesta Corp—Received EPA registration for use on trees, shrubs, evergreens, flowers,
foliage plants, groundcover, and interior landscapes to control aphids, whiteflies, and mealybugs.

MERIT (imidacloprid)—Bayer Environmental Science—Added to their label the control of the Emerald ash borer.

Structural

PHANTOM (chlorfenapyr)—BASF—
Received an EPA label to use in food- and feed-handling areas and establishments.

PROFUME (Sulfuryl fluoride)—Dow AgroSciences—Added to their label the control of rodents and insects in transportation vehicles and in food establishments.

Many

BALLAD (Bacillus pumilus QST 2808)—Agra Quest—A new formulation for use on soybeans, cereals, and potatoes to control rust, powdery mildew, and blight.

BELEAF (flonicamid)—FMC—A new insecticide for use on certain vegetables, tree crops, nut crops, and grapes to control aphids.

BIOMITE (citronellol/geraniol/neroli-dol)—Natural Plant Protection—EPA approved an application to register this new active ingredient to control mites on agricultural crops, on ornamental plants, and in professional landscape settings. (FR, vol. 69, 12-29-04)

DACTHAL (DCPA)—Amvac—The manufacturer has sent a request to EPA to terminate the use of this product on alfalfa, arracacha, artichokes (Chinese and Jerusalem), beans, bean yam, beets, chestnuts (soil treatment and nursery stock), chufa, citron melon, cotton, crapapples (soil treatment and nursery stock), cucumber, edible canna, eggplant, garlic, ginger, kale, leren, peas, pepper, potatoes, residential uses (turf and ornamentals), squash (including pumpkin), sweet potatoes, turnier, turnips, walnuts (nonbearing and nursery stock), and yam. They requested this be effective 4-1-05 and existing stock be used by 4-1-07. Comments must be received by 3-18-05. (FR, vol. 70, 2-16-05)

GUTHION (azinphos-methyl)—Bayer Crop Science—Proposed to EPA to cancel their registration on caneberrries, cotton, cranberries, nectarines, peaches, potatoes, and southern pine seed orchards. The comment period expired 3-30-05. (FR, vol. 70, 2-28-05)

METCONAZOLE—Kureha Chemical Industry—The company will jointly develop this fungicide with Sumitomo for the U.S. and Canadian market on turf, fruit trees, and vegetables. It will be marketed in North America by Sumitomo’s subsidiary company, Valent USA.

T-22 (Trichoderma harzianum strain KRL-A2)—Bio Works—Added to their label for this biofungicide the use on wheat.

THRIRAM—Taminco/Gustafson—EPA has approved the reregistration of this product. However, it is canceling use in park, athletic fields, commercial landscapes, commercial turf, residential lawns, flower seeds, bulbs, greenhouse and nursery cuttings; and in pruning paints. The rate as a deer repellent has also been reduced. [fungicide]

Other

AMVAC—The company has entered into an agreement with BASF to develop and market BASF’s new postemergent corn herbicide Topramezone, for the North American market.

AGRIUM—This Canadian fertilizer company purchased from United Agri Products, 18 crop protection retail outlets in South America.

AQUAMASTER (glyphosate)—Monsanto—Added to their label the control of Japanese knotweed and giant knotweed.

BASF—The company has added two new fungicides to its line of products to control Asian soybean rust on soybeans in the United States. The company has obtained marketing rights to Tebucona-zole from Bayer and to Metconazole from Kureha Chemical Industries. These will be marketed in conjunction with other BASF fungicide products.

BAYER CROP SCIENCE—The company has made a multi-year supply agreement for its Orius (tebuconazole) fungicide to Makhteshim Agan. They will attempt to get registration and market on all crops in the United States.

CEREXAGRI—The company has made an agreement with Agro Source to market their oxytetracycline (Flame Out) and streptomycin (Fire Wall) antibiotic fungicides.

CROMPTON—The company will market Nissan Chemical’s herbicide Targa (quizalofop-p-ethyl) in the United States this spring. It is a postemergence grass-control product used on cotton, soybeans, sugarbeets, and other crops.

MAKHTESHIM AGAN (MAI)—The company will move its U.S. offices from New York City to Raleigh, NC, in the near future.

MONSANTO—The company has purchased Seminis, the world’s largest supplier of vegetable seed for $1.4 billion, and Emergent Genetics, the third-largest cotton seed–producing company in the United States. This will make Monsanto the world’s largest seed company. Also, American Seeds Inc., which is a subsidiary of Monsanto, has acquired the seed corn company NC+ Hybrids.

OVO CONTROL (Nicarbazine)—Inno-lyties LLC—A new product being developed to reduce urban goose and pigeon population growth. It is applied as a bait.

SCOTTS CO.—The home and garden manufacturer has changed its name to Scotts Miracle-Gro Co.

SUMITOMO—The company has acquired from BASF the fungicide Triforine on a worldwide basis. The product is currently sold under the trade names Funginex, Denarin, and Saporl.

(Michelle Wiesbrook, unless otherwise noted, adapted from Agricultural Chemical News, March and April 2005.)