

SusAg 530
Ecologically Based Pest Management Strategies
SYLLABUS, Fall 2006

Instructors

Matt Liebman
(Department of Agronomy, 3405 Agronomy Hall, mliebman@iastate.edu, 294-7486)

Matt O'Neal
(Department of Entomology, 117 Insectary, oneal@iastate.edu, 294-8622)

Mark Gleason
(Department of Plant Pathology, 313 Bessey Hall, mgleason@iastate.edu, 294-0579)

Course Description

SUSAG 530 is a three-credit course designed to introduce graduate students to the principles and practices of ecologically based pest management. The course emphasizes the management of weeds, insects, mites, fungi, bacteria, viruses, and nematodes interfering with crop production. Students will gain familiarity with basic concepts of population and community ecology relevant to pest management. They will also gain experience with systemic thinking using a modeling program called STELLA. Case studies will address the ecology and management of weeds, arthropods, and pathogens in a range of agricultural systems. Students will design and examine the feasibility of systems for managing multiple pests. The course is co-listed as Agron 530, Ent 530, and PI P 530.

Background

In its 1996 publication titled *Ecologically Based Pest Management: New Solutions for a New Century*, the National Research Council (NRC) identified three goals for pest management: profitability, safety, and durability. Achieving these goals requires improved understanding of how ecosystem processes, such as predation, parasitism, herbivory, competition, and mutualism, can be manipulated effectively. The NRC report noted that the theoretical base of ecologically based pest management (EBPM) is similar to that of integrated pest management (IPM), but pointed out that the actual practice of IPM often has differed significantly from the intended approach. Specifically, the NRC report noted that IPM practice has focused more on insect pests than on weeds, pathogens, and vertebrate pests, and has, in many cases, emphasized improved use of pesticides rather than better management of fundamental ecosystem processes. For these and other reasons, the NRC recommended the development of EBPM systems that take a broader view of all pests within an agroecosystem context.

In the spirit of the NRC report, SusAg 530 emphasizes ecological principles and their applications in pest management strategies. The course is designed to provide graduate students with a broad overview of pest management in the context of whole farming

systems. Thus, it differs from existing courses in weed science, entomology, and plant pathology that focus more on specific control tactics. SusAg 530 is intended to complement ISU graduate courses and research work in specific pest management disciplines and the interdepartmental undergraduate program in integrated pest management.

Graded Activities

Grades will be based on several homework assignments (25% of total points), a project report (25% of the total), and two take-home exams (50% of the total). The course instructors will evaluate final project reports. The two take-home examinations will cover reading materials, lectures, and in-class discussions.

Text Materials and Software

Reading assignments will be drawn from a diverse set of sources. Most materials will be journal articles and books chapters. All reading materials can be viewed as PDFs or internet links on the Parks Library Reserve web site (<http://www.lib.iastate.edu/class/ers/course.html>). There is no cost for the electronic text materials. Reading materials will be used as the basis of in-class discussions in which all students are expected to participate.

Homework exercises and the class project will require use of the STELLA modeling program. STELLA will be introduced in class, but *the major part of learning how to use this program will be the outside-class responsibility of each student*. Learning STELLA is like learning a language. Practice, self-directed exploration, curiosity, patience, and persistence will pay off.

Students in SUSAG 530 will have access to STELLA software and supporting materials through the ORBIS server (<http://orbis.eeob.iastate.edu>). At the ORBIS website, you will see "Remote Desktop" options for both Mac and Windows platforms. You will need your net ID and password to work with Remote Desktop. Through Remote Desktop, you will be working and storing materials on a central server, not your own computer. However, when you log on, options are provided for connecting to your own printer and various drives. Detailed instructions for operating in the Remote Desktop mode are available at the ORBIS site, but you can probably figure out what you need to do through trial and error.

Once you are in the Remote Desktop mode, you can find the STELLA program and many supporting documents and tutorials. Enter "All Programs" and then follow through to STELLA 7.0.3 (or 9.0). You can then explore "A Getting Started Guide," which contains on-line tutorials; "An Introduction to Systems Thinking," which explains the philosophy and general approach to modeling with STELLA; "Simple Samples," which contains a model of predator-prey dynamics in the Biology and Environmental Science folder; and a "Help" manual, which you will use a lot to find answers to technical questions.

In the corner of Remote Desktop, you will find a class folder in which your homework exercises and projects can be stored. You will have your own personal folder that will be

accessible only to you and the course instructors. There will also be general access folders, where class materials will be available to everyone in the course.

Students who wish to have their own copy of STELLA can purchase a six-month license for the software for \$59 from ISEE Systems (<http://www.iseesystems.com>; 1-800-987-6758 or 603-448-4990). Permanent licenses for the software are available at a higher cost; contact ISEE Systems for a price quote.

Projects

Students will work in groups to develop a pest management program for a cropping system that is of interest to the group and acceptable to the instructors. The cropping system can be one that already exists or one that could exist in the future if certain (specified) constraints were removed. Each group will identify key pests in its study system, gather research-based information concerning the ecology of those pests, develop an integrated management strategy, and examine the strategy's ecological and economic feasibility. The project will include a substantial modeling component. If a student prefers to work alone rather than in a group, s/he can do so. Grades for all students will be based on overall project quality and individual contributions.

Each project report will contain four sections:

Section 1: Introduction and definition of the problem, and statement of the project's objectives (3-4 pages, 20% of project grade). This section should provide a description of the farming system, including key pests and their impacts on crops, and factors affecting pest and natural enemy dynamics. Critical ecological information should be given.

Section 2: Pest ecosystem model (5-10 pages, 30% of project grade). This section should identify components of the system and explain their relationships with one another. Controllable and monitored factors affecting each component should be described. Focal points for the development of pest management strategies and for the implementation of pest management tactics should be identified.

Section 3: Design for implementation (5-10 pages, 30% of project grade). Using their pest ecosystem models as guides, students should design management strategies that are effective, safe, durable, and profitable. The roles of modeling and environmental and biological monitoring should be discussed.

Section 4: Expected impacts and feasibility analysis (3-4 pages, 20% of project grade). Students should consider the short- and long-term impacts of their pest management programs on crop production and quality, pest populations, and financial returns.

Schedule

Week 1

22 Aug: Overview of the course and course procedures, the concepts of ecologically based pest management and agroecosystem design (Liebman)

Reading:

Lewis, W.J., J.C. van Lenteren, S.C. Phatak, and J.H. Tumlinson III. 1997. A total system approach to sustainable pest management. *Proceedings of the National Academy of Sciences, USA* 94: 12243-12248.

Rosset, P.M. and M.A. Altieri. 1997. Agroecology versus input substitution: a fundamental contradiction of sustainable agriculture. *Society and Natural Resources* 10: 283-295.

24 Aug: Examples of ecologically based pest management systems (Liebman)

Reading:

Anon. 2000. *A Whole-Farm Approach to Managing Pests*. Sustainable Agriculture Network, USDA Sustainable Agriculture Research and Education Program, Beltsville, MD. Available on-line at: <http://www.sare.org/publications/farmpest/farmpest.pdf>.

Khan, Z.R., J.A. Pickett, J. van den Berg, L.J. Wadhams, and C.M. Woodcock. 2000. Exploiting chemical ecology and species diversity: stem borer and striga control for maize and sorghum in Africa. *Pest Management Science* 56: 957-962.

Khan, Z.K., A. Hassanali, W. Overholt, T.M. Khamis, A.M. Hooper, J.A. Pickett, L.J. Wadhams, and C.M. Woodcock. 2002. Control of witchweed *Striga hermonthica* by intercropping with *Desmodium* spp., and the mechanism defined as allelopathic. *Journal of Chemical Ecology* 28: 1871-1885.

Week 2

29 Aug: Introduction to population ecology and STELLA (O'Neal).

Reading:

Mackenzie, A., A.S. Ball, and S.R. Virdee. 1998. *Instant Notes in Ecology*, pp. 71-83 (population ecology), 107-110 (predation). Springer-Verlag, New York, NY.

Price, P.W. and G.P. Waldbauer. 1994. Ecological aspects of pest management, pp 35-72 in R.L. Metcalf and W.H. Luckmann (eds). *Introduction to Insect Pest Management*, 3rd edition.

Over the course of the next two lectures, work through the five model building and simulation tutorials in the STELLA software package. Look at and gain familiarity with the contents of the "Help" folder.

31 Aug: Introduction to STELLA--continued (Liebman).

Week 3

5 Sept: Insect biocontrol model–first homework (O’Neal).

Reading:

Chang, G.C. and P. Kareiva. 1999. The case for indigenous generalists in biological control. Pages 103-115 in: B.A. Hawkins and H.V. Cornell (eds.). *Theoretical Approaches to Biological Control*. Cambridge University Press, Cambridge, UK.

Wiedenmann, R.N. and J.W. Smith Jr. 1997. Attributes of natural enemies in ephemeral crop habitats. *Biological Control* 10: 16-22.

Landis, D., S. Wratten, and G. Gurr. 2000. Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology* 45: 175-201

7 Sept: Case study–IPM in the midwestern USA (O’Neal).

Reading:

Gray, M.E. 2001. Prescriptive use of transgenic hybrids for corn rootworms: an ominous cloud on the horizon? Department of Crop Sciences, University of Illinois, Urbana-Champaign, IL. Available on-line at: http://www.cropsci.uiuc.edu/faculty/mgray/publications/ICPTC_2000.pdf.

Onstad, D.W., D.W. Crowder, S.A. Isard, E. Levine, J.L. Spencer, M.E. O’Neal, S.T. Ratcliffe, M.E. Gray, L.W. Bledsoe, C.D. DiFonzo, and B. Eislely. 2003. Does landscape diversity slow the spread of rotation-resistant western corn rootworm (Coleoptera: Chrysomelidae)? *Environmental Entomology* 32: 992-1001.

U.S. General Accounting Office. 2001. *Agricultural Pesticides: Management Improvements Needed to Further Promote Integrated Pest Management*. Report GAO-01-815. USGAO, Washington, DC. Available on-line at: <http://www.gao.gov/new.items/d01815.pdf>.

Week 4

12 Sept: Combining top-down and bottom-up factors for pest management (O’Neal).

Reading:

James, DG, and T.S. Price. 2004. Field-testing of methyl salicylate for recruitment and retention of beneficial insects in grapes and hops. *Journal of Chemical Ecology* 30: 1613-1628.

Rasmann S, Kollner TG, Degenhardt J, I. Hiltbold, S. Toepfer, U. Kuhlmann, J. Gerxhonzon, and T.C.J. Turlings. 2005. Recruitment of entomopathogenic nematodes by insect damaged maize roots. *Nature* 434: 732-737.

14 Sept: Introduce projects. Hand in and review first homework assignment: key findings, ways to improve models (O’Neal).

Week 5

19 Sept: Weed life histories and vulnerabilities to management tactics at different life history stages (Liebman).

Reading:

Mohler, C.L. 2001. Weed life histories: Identifying vulnerabilities. Pages 40-98 in: M. Liebman, C.L. Mohler, and C.P. Staver, *Ecological Management of Agricultural Weeds*. Cambridge University Press, Cambridge, UK.

21 Sept: Building a simple model of weed population dynamics in corn based rotation systems–second homework (Liebman).

Week 6

26 Sept: Multi-tactic weed management strategies (Liebman).

Reading:

Hatcher, P.E. and B. Melander. 2003. Combining physical, cultural, and biological methods: prospects for integrated non-chemical weed management strategies. *Weed Research* 43: 303-322.
Liebman, M. and E.R. Gallandt. 1997. Many little hammers: Ecological approaches for managing weed-crop interactions. Pages 291-343 in L.E. Jackson (ed.), *Ecology in Agriculture*. Academic Press, San Diego, CA.

28 Sept: Hand in and review second homework assignment: key findings, ways to improve models (Liebman).

Week 7

3 Oct: Case study–Habitat management for pest control in a minor crop (O’Neal).

Reading:

Isaacs, R., Z. Szendrei, and J. Wise. 2004. Evaluation of new approaches for management of Japanese beetles in highbush blueberries. *Small Fruit Review* 3: 349-360.
Isaacs, R., M.E. O’Neal, Z. Szendrei, and J. Tuell. 2004. Potential of ground covers for manipulating pest, predator and pollinator populations in highbush blueberry. *International Organization of Biological Control –West Palearctic Regional Section (IOBC-WPRS) Bulletin* 27(4): 17-24.
O’Neal, M.E., E.L. Zontek, Z. Szendrei, D.A. Landis, and R. Issacs. 2005. Ground predator abundance affects prey removal in highbush blueberry (*Vaccinium corymbosum*) fields and is increased by ground covers. *BioControl* 50: 205-222.

5 Oct: Pesticide use and pollinators. (O’Neal).

Reading:

Buchmann, S.L. and G.P. Nabhan. 1996. Pages 185-201 (Chapter 11: The little lives keeping crops fruitful) and pp. 203-215 (Chapter 12: Pollinator gardens and ecological restoration). *The Forgotten Pollinators*. Island Press/Shearwater Books, Washington, D.C. and Covelo, CA.
Kremen, C., N.M. Williams, and R.W. Thorp. Crop pollination from native bees at risk from agricultural intensification. *Proceedings of the National Academy of Science* 99: 16812-16816.
Javorek, S.K., K. E. Mackenzie, and S.P. Vander Kloet. 2002. Comparative pollination effectiveness among bees (Hymenoptera: Apoidea) on low bush blueberry (Ericaceae: *Vaccinium angustifolium*). *Annals of the Entomological Society of America* 95: 343-351.

Week 8

10 Oct: Environmental conditions and disease incidence and severity (Gleason).

Reading:

Campbell, C. L. and L. V. Madden. 1990. *Introduction to Plant Disease Epidemiology*, pages 129–138 (modeling and data analysis); 161-175 and 192-194 (disease progression curves). John Wiley and Sons, New York, NY.

12 Oct: Building a model of pathogen population dynamics in response to weather conditions and management tactics–third homework (Gleason).

Week 9

17 Oct: Case study: Apple production in the USA (Gleason).

Reading:

Kovach, J., C. Pezoldt, J. Degni, and J. Tette. 1992. A method to measure the environmental impact of pesticides. New York's Food and Life Sciences Bulletin, No. 139. Cornell University, Ithaca, NY.
Merwin, I.A., S.K. Brown, D.A. Rosenberger, D.R. Cooley, and L.P. Berkett. 1994. Scab-resistant apples for the northeastern United States: New prospects and old problems. *Plant Disease* 78: 4-10.
Prokopy, R.J., J.L. Mason, M. Christie, and S.E. Wright. 1996. Arthropod pest and natural enemy abundance under second-level versus first-level integrated pest management practices in apple orchards: A 4-year study. *Agriculture, Ecosystems, and Environment* 57: 35-47.
Reganold, J.P., J.D. Glover, P.K. Andrews, and H.R. Hinman. 2001. Sustainability of three apple production systems. *Nature* 410: 926-930.

19 Oct: First exam handed out. Host/pathogen interactions above- and belowground. Hand in and review third homework assignment: key findings, ways to improve models (Gleason).

Reading:

Van Bruggen, A.H.C. 1995. Plant disease severity in high-input compared to reduced-input and organic farming systems. *Plant Disease* 79: 976-984.

Week 10

24 Oct: Biological control of plant diseases. Case study: Tomato production in California (Gleason).

Reading:

Clark, M.S., H. Ferris, K. Klonsky, W.T. Lanini, A.H.C. van Bruggen, and F.G. Zalom. 1998. Agronomic, economic, and environmental comparison of pest management in conventional and alternative tomato and corn systems in northern California. *Agriculture, Ecosystems, and Environment* 68: 51-71.
Clark, M.S., W.R. Horwath, C. Shennan, K.M. Scow, W.T. Lanini, and H. Ferris. 1999. Nitrogen, weeds and water as yield-limiting factors in conventional, low-input, and organic tomatoes. *Agriculture, Ecosystems, and Environment* 73: 257-270.
Drinkwater, L.E., D.K. Letourneau, F. Workneh, A.H.C. van Bruggen, and C. Shennan. 1995. Fundamental differences between conventional and organic tomato agroecosystems in California. *Ecological Applications* 5: 1098-1112.

26 Oct: First exam due. Case study–Hosta. (Gleason).

Reading:

Edmunds, B.A., P.H. Flynn, and M.L. Gleason. 2003. Hosta takeover: a plant disease management case study. *The Plant Health Instructor*. American Phytopathological Society, St. Paul, MN. Available on-line at:
<http://www.apsnet.org/education/InstructorCommunication/TeachingArticles/hosta/thecase.htm>.

Week 11

31 Oct: Case study–Rice production in Asia (Liebman).

Reading:

Andow, D.A. and K. Hidaka. 1989. Experimental natural history of sustainable agriculture: Syndromes of production. *Agriculture, Ecosystems, and Environment* 27: 447-462.
Matteson, P.C. 2000. Insect pest management in tropical Asian irrigated rice. *Annual Review of Entomology* 45: 549-574.

Settle, W.H., H. Ariawan, E.T. Astuti, W. Cahyana, A.L. Hakim, D. Hindayana, A.S. Lestari, and Pajarningsih. 1996. Managing tropical rice pests through conservation of generalist natural enemies and alternative prey. *Ecology* 77: 1975-1988.

Zhu, Y., H. Chen, J. Fan, Y. Wang, Y. Li, J. Chen, J. Fan, S. Yang, L. Hu, H. Leung, T.W. Mew, P.S. Teng, Z. Wang, and C.C. Mundt. 2000. Genetic diversity and disease control in rice. *Nature* 406: 718-722.

2 Nov: Toward the integration of soil, crop, and weed management (Liebman).

Reading:

Liebman, M. and A.S. Davis. 2000. Integration of soil, crop and weed management in low-external-input farming systems. *Weed Research* 40: 27-47.

Week 12

7 Nov: The future of pest management (Liebman, Gleason, and O'Neal).

Reading:

Vorley, W. and D. Keeney. 1998. Solving for pattern. Pages 193-215 in W. Vorley and D. Keeney (eds.). *Bugs in the System: Redesigning the Pesticide Industry for Sustainable Agriculture*. Earthscan Publications, Ltd., London, UK.

9 Nov: Guest speaker: Dr. Paula Westerman, Iowa State University. Reductions in pesticide use in the Netherlands.

Week 13

14 Nov: Guest speaker: to be determined.

16 Nov: Dr. Mirko Ivanovic, University of Belgrade. IPM in Serbia.

Week 14

21, 23 Nov: Thanksgiving break.

Week 15

28 Nov: Presentations of student projects.

30 Nov: Presentations of student projects.

Week 16

5 Dec: Presentations of student projects.

7 Dec: Second exam handed out. Presentations of student projects.

DISABILITY POLICY: Iowa State University complies with the Americans with Disabilities Act and Section 504 of the Rehabilitation Act. Any student who requires an accommodation should contact the course instructors early in the semester so that his/her learning needs may be met appropriately. Documentation of disability should be provided to the Disability Resources (DR) office, 1076 Student Services Building, 515-294-6624, <http://www.dso.iastate.edu/dr/>. The DR office can assist students in writing Student Academic Accommodation Requests (SAAR) and in arranging appropriate accommodations.