V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Plant Health, Systems And Production

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	5%		10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		15%	
205	Plant Management Systems	25%		10%	
206	Basic Plant Biology	25%		10%	
211	Insects, Mites, and Other Arthropods Affecting Plants	20%		10%	
212	Diseases and Nematodes Affecting Plants	20%		13%	
213	Weeds Affecting Plants	0%		12%	
216	Integrated Pest Management Systems	5%		10%	
402	Engineering Systems and Equipment	0%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	8.0	0.0
Actual Paid	0.0	0.0	10.6	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
418246	0	894184	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
418246	0	894184	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
3358128	0	12322850	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities in 2014 included studies to observe the effects of the addition of cover crops on organic grain production systems, a discovery suggesting that sigma factor cascade in E. amylovora exists in its regulatory networks and regulates important virulence factors [sigma factors, including alternative sigma factors, are essential transcription initiation factors that direct RNA polymerase to bind specific promoter regions], the testing of over 1,300 individual waterhemp plants from over 320 fields for specific herbicide resistance traits and the evaluation of glyphosate-resistant waterhemp plants from Illinois and other Midwest states for the presence of EPSPS gene amplification [the EPSPS gene encodes the target enzyme of glyphosate, and amplification of this gene is one of the known mechanisms of glyphosate resistance], ongoing work to establish a long-term research experiment plot to provide necessary calibration of a decision support system for agrotechnology transfer [DSSAT], research with the overall goal of understanding the biology of X. cucurbitae and determining the etiology and epidemiology of bacterial spot for developing effective strategies for management of the disease, the development and testing of new experimental lines for yield, agronomic traits, and disease and pest resistance under the University of Illinois soybean breeding program [the program grew over 3,000 4-row yield test plots, over 6,600 2-row yield plots, and over 11,000 plant row plots], a new project that evaluated the effect of cover crops on diseases and pathogens [treatments included several fall-planted cover crops including cereal rye, hairy vetch, hairy vetch/rye mix, mustard, and a fallow control, superimposed on tillage treatments of ridge-till and chisel plowing], the development of a system to measure respiration rates of corn and soybeans [results of the study will be used to estimate dry matter losses and will be used to determine maximum allowable storage times for corn and soybeans in high temperature and high moisture environments], ongoing improvement of the Varietal Information Program for Soybeans [VIPS] database [VIPS provides important results on soybean varieties planted throughout the State of Illinois and how they delivered for yield as well as providing key information on weed resistance, disease and insect resistance, and a renewed focus on quality measurements such as protein and oil content and amino acid profiles], and the use of a high-throughput single nucleotide polymorphism [SNP] genotyping assay to investigate relationships of Malus species, draw inferences on the domestication history, identify traits critical for domestication, and assess potential genetic loci under selection.

Activities in 2014 also included the development of improved winter wheat varieties adapted to Illinois, research with the goal of developing a rapid approach to discovering new viruses in plant parasitic nematodes, work to improve methods used to manage Palmer amaranth [simply attempting to control Palmer amaranth often leads to ineffective herbicide applications, substantial crop yield loss, and increasing weed infestations], research to determine the reproductive stage at which weeds can be

terminated and still produce viable seed, work to determine the effects of planting date and plant population on yield of recent corn hybrids [with a view toward formulating new planting and replanting guidelines and assessing foliar fungicide effects on corn planted at different times], the use of RNA Seq to reveal gene networks involved in seed development and early seedling growth programs, oilseed research focusing on responses of soybeans to growth under elevated ozone and carbon dioxide, and the characterization of the roles of the FT/TFL1 gene family in photoperiodic flowering in Arabidopsis [the flowering transition is central to reproductive success in plants and for determining environmental fitness].

Conference presentations in 2014 included the American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, Illinois Fertilizer and Chemical Association, Illinois Specialty Crops, Agritourism, and Organics, XXIV Congreso Argentino de la Ciencia del Suelo y II Reunión Nacional Materia Orgánica y Sustancias Húmicas, Twentieth World Congress on Soil Science, MOSES Organic Farming Conference, NASA Astrobiology Institute Seminar Series, 10th International Congress of Plant Pathology, Society for Horticultural Science International Fire Blight Workshop, Livingston County Farm Bureau Agronomy Day, Northern Illinois Agronomy Research Center Corn Rootworm Session, University of Illinois' Agronomy Day, American Phytopathological Society, Cucurbitaceae 2014, Soybean Breeders' Workshop, North Central Soybean Research Program Board, Molecular and Cellular Biology of the Soybean Conference, West Africa Centre for Crop Improvement, Corn and Soybean Classics, American Society of Agricultural and Biological Engineers, Weed Science Society of America, North Central Weed Science Society, American Association of Cereal Chemists, American Soybean Association, American Seed Trade Association, Corn and Sorghum Seed Research Conference, Short Rotation Woody Crops Operations Working Group, Corn, Soybean, and Sorghum Research Conference, Molecular and Cellular Biology of Soybean, and the Institute of Food Technologists.

Extension activities focused on both food and non-food horticulture crops and pests. The **Ask Extension--Hort Corner** program is comprised of multiple topics [many of which are in Spanish] that received 561,057 views during the past year. The site allows visitors to ask a question of a University of Illinois Extension Educator or review the questions asked and answers received by previous visitors via an online web form. A series of nine horticulture distance education programs titled **Four Seasons Gardening** was offered at Extension offices throughout the state during the fall and spring with a total attendance of 1,940. Topics included herbs, pest control strategies in the garden, bargain gardens, home orchards, youth gardens, West Nile Virus, day lilies, rain gardens, and hydroponics.

Extension Master Gardeners gave countless hours in providing horticulture information to the public. This past year, 560 new Master Gardeners completed training at various locations in the state [118 were trained via the online program]. Pre- and post-tests indicated that 324 of the trainees who completed both tests increased their knowledge by 26.6%. In total there were 3,200 active Master Gardeners in Illinois who made more than 164,000 direct teaching contacts and contributed more than 198,000 volunteer hours with an overall economic value of their contributions estimated to be $4.77 million. More than half of these hours were devoted to teaching audiences how to grow, preserve, and share or sell excess produce to enhance the consumption of food rich in required nutrients for good health. Master Gardeners were also involved in making presentations, providing technical support and therapeutic assistance to individuals and facilities, and creating opportunities for children to learn about and grow food and to enjoy nature. Award-winning garden projects this past year included creation of an heirloom perennial garden in collaboration with a museum, maintaining a garden at a local hospital site to improve the health of employees and information for guests, school gardens, establishment of a native butterfly hoop house at a wildlife prairie park, a garden at a zoo, and community gardens focused on donating produce to local food pantries.

A series of online training **Integrated Pest Management** modules which cover pertinent plant pests,

weeds, and diseases are focused on pests that are newly emerging, exotic, or invasive. Each module includes information on how to identify the pest as well as current management options [stressing those methods which offer the best long term control with minimal environmental impact]. This past year two new modules were added to the existing 10 modules [one for Gypsy Moth and a second for Oak Problems]. The 12 modules were developed for Master Gardeners but were available to home gardeners and green industry professionals. Master Gardeners throughout the North Central region have been using these modules as credit towards required continuing education hours and as a reference to answer client home gardening questions. Since first offered in 2011-12, credit has been awarded for completion of 2,375 modules.

The **University of Illinois Plant Clinic** had a total of 8,494 diagnostic service contacts in 2014 [1,800 telephone inquiries, 2,500 email and App requests, and 600 walk-in consultations] and 3,807 plant samples. Clinic staff members also made presentations and provided demonstration materials for numerous outreach programs that included Master Gardener plant disease and IPM training courses, the Extension Crop Management Conferences and various plant-related trade shows and conferences. Clinic staff also assisted with the **2014 Illinois First Detector** invasive pests statewide workshops conducted in conjunction with the Illinois Natural History Survey, the Illinois Department of Agriculture, and the Illinois Department of Natural Resources hosted at Extension offices. In addition, 23 articles were prepared for inclusion in one or more of the 16 issues of the **Home Yard and Garden newsletter** which had approximately 232,000 visits and nearly 439,000 page views. Clinic staff also maintained social media activities that included website information [55,333 page views] , Facebook [1,255 followers/80,215 reached], podcasts [2,765 views], YouTube videos [230 views] and 3,000 plant diagnostic App downloads.

The Extension **Digital Diagnostic System** provided outreach to homeowners and commercial producers in diagnosing and providing solutions for 276 samples of invasive and exotic species pests. The Extension **Pesticide Safety Education** training program reached 1,318 private [farmer] pesticide applicators and 9,164 commercial applicators this past year providing information on proper and safe use of pesticides that is vital to Illinois residents with respect to public health protection and environmental stewardship.

2. Brief description of the target audience

Members of the target audience included nematologists and other scientists in the plant protection field, scientists in the fire blight research community and related enterobacterial areas, corn and soybean producers, commercial entomology and crop protection/pest management professionals, Extension personnel, agricultural biotechnology company representatives, college students in the agricultural sciences, the weed science community and practitioners of weed management, plant pathologists, crop scientists, researchers and practitioners focusing on grain harvest, handling, and transportation, researchers interested in woody plant biomass production, evaluation, and yields, scientists engaged in the studies of plant evolution, genetics, and breeding, retail suppliers of agricultural inputs, and public and private media sources. Extension audiences included homeowners, Master Gardeners, green industry owners and employees [landscapers, nursery stock growers, lawn and garden business owners and employees, insurance adjusters, and arborists] and crop producers.

3. How was eXtension used?

Four Extension staff members are members of the Consumer Horticulture or Invasive Species eXtension Communities of Practice.

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	74601	239134	22309	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2014

Actual: 4

Patents listed

TF 11129-US [Compositions and Methods for Modulating Anthocyanin Accumulation and Pistil Development] and TF 14053-PRO [Detection and Association of Variation to Heritability]. Issued Patents: 8,680,364 [Soybean Genes for Resistance to Aphis Glycines], and 8,692,053 [Soybean Genes for Resistance to Aphis Glycines].

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	63	63

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Research Projects

Year	Actual
2014	3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	More Informed User Of Pesticides
2	Choosing Plant Varieties That Are Known To Be Resistant To Insects And Diseases
3	Improved Control Of Waterhemp
4	Studying The Interaction Of Photosynthesis, Genotype, And Environment To Improving Maize Production
5	Development Of Rust-Resistant Lines For Illinois Soybean Growers
6	Identification Of Nematode Pathogens Using DNA Sequencing
7	Development Of Improved Soft Red Winter Wheat Varieties
8	Evaluating The Effectiveness Of Cover Crops In Reducing Disease Severity
9	Identification And Evaluation Of The Many Possible Functions Of Cover Crops
10	Developing New Strategies For Controlling Fire Blight
11	Increasing The Yield Potential And Pest Resistance Of Soybean Cultivars In Illinois
12	Documenting The Occurrence And Distribution Of Herbicide-Resistant Weed Populations In Illinois
13	Determining The Reproductive Stage At Which Weeds Can Be Terminated And Still Produce Viable Seed
14	Assessing The Effects Of Various Stresses On Crop Yield And Quality
15	Determining The Role Of Root Architecture On Abiotic Stress Tolerance In Maize
16	Investigating The Impact Of Elevated CO2 And O3 On Soybeans
17	Number Of Individuals Increasing Knowledge Related To Detecting And Managing Invasive Pests

Outcome #1

1. Outcome Measures

More Informed User Of Pesticides

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	188

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The demand for good horticultural information by homeowners frequently outstrips the number of Extension educators who can supply the needed input.

What has been done
Master Gardener multl-county training sessions and online training were completed by 560 new volunteers in 2014. An online evaluation survey was completed this past year by 269 new [between two and four years of experience] Master Gardeners. The survey was designed by the state coordinator of Master Gardeners to assess 13 gardening practices, 11 personal improvement skills, and Master Gardener experience in teaching horticulture topics.

Results
Pre- and post-tests completed by 269 of the new Master Gardeners evidenced that 95% [255] of the respondents indicated that they adopted at least one of the 13 gardening practices. Specifically, 188 [70%] of the respondents reported now identifying an insect, disease or weed problem before deciding on a control measure and choosing plant varieties that are known to be resistant to insects and diseases. In addition, approximately one-half are now keeping records of pest occurrence and control methods for later reference. More than one third are now using pesticides according to the container label. Complete results from the survey are indicated in the evaluation section of this planned program.

4. Associated Knowledge Areas

KA Code	Knowledge Area

205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Diseases and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems

Outcome #2

1. Outcome Measures

Choosing Plant Varieties That Are Known To Be Resistant To Insects And Diseases

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Improved Control Of Waterhemp

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A population of waterhemp [designated MCR] from a seed corn field in McLean County, Illinois displays resistance to mesotrione and other 4-hydroxyphenylpyruvate dioxygenase [HPPD] inhibitors, as well as to atrazine and certain acetolactate [ALS]-inhibiting herbicides. Our prior field and greenhouse results indicated that this waterhemp biotype is resistant to mesotrione [and all commercial HPPD-inhibiting herbicides used for weed control in maize] and atrazine, from both preemergence and postemergence applications, mainly due to the rapid metabolism of mesotrione and atrazine [although by different detoxification mechanisms and enzymes]. These research findings are particularly significant and relevant for crop production and weed management with postemergence [POST] herbicides in maize because several other waterhemp

populations have recently been identified in seed corn fields throughout the Midwest that possess this unique form of multiple herbicide resistance, which is based on herbicide detoxification.

What has been done
Our previous research reported metabolic-based resistance to mesotrione in a waterhemp population designated MCR [for McLean County, Illinois HPPD-resistant]. Elevated rates of oxidative metabolism, presumably catalyzed by cytochrome P450 monooxygenases [P450s], contributed significantly to mesotrione resistance within the MCR population. Experiments were conducted to test the hypothesis that higher expression levels of specific P450s correlate with mesotrione resistance in the MCR population. Another mesotrione-resistant population, CHR [for Champaign County, Illinois HPPD-resistant], and several other mesotrione-sensitive waterhemp populations were used for comparison with MCR. Total RNA extracted from meristem and new leaf tissue from individual waterhemp plants of the same ages and height [10 cm] were used for real-time quantitative reverse transcriptase-polymerase chain reaction [qRT-PCR] analysis to compare transcript levels of candidate P450 genes among populations. Primers were designed from conserved regions between several candidate maize and Helianthus P450 cDNAs and the most similar P450 contigs in the waterhemp transcriptome. qRT-PCR demonstrated that a P450 transcript most similar to a maize P450 gene is more highly expressed in meristem tissue of MCR and CHR seedlings [10 cm] compared with each mesotrione-sensitive waterhemp population. Significant differences in expression were not detected when comparing two additional candidate P450s among these waterhemp populations at a height of 10 cm.

Results
Expression of the maize P450 homolog in waterhemp, in meristem tissues from MCR seedlings harvested at 4, 6, 8, and 10 cm, was significantly higher than in WCS [for Wayne County, Illinois, herbicide-sensitive] seedlings, but not in 2 cm seedlings or in roots harvested from 10 cm plants. Therefore, only expression of this maize homolog in waterhemp correlated with POST mesotrione resistance and growth-stage results in MCR and CHR suggested that P450 expression might be growth-stage dependent. Expression of this P450 marker gene can therefore be used for future molecular-genetic and functional genomics work to further investigate the association of its expression patterns with the resistant phenotype discovered in our research. Additionally, growth-stage results suggest that P450 expression may be growth-stage dependent, which negatively correlates with POST mesotrione control of waterhemp under field conditions. For example, significantly greater waterhemp control is obtained when mesotrione is applied POST to smaller waterhemp plants [2-5 cm tall] compared to plants at 5-10 or 10-15 cm tall. Current research is being conducted to quantify P450 expression in F2 segregating lines as well as to obtain and compare the entire cDNA sequences of this gene in MCR, CHR, and WCS waterhemp populations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
206	Basic Plant Biology
213	Weeds Affecting Plants
216	Integrated Pest Management Systems

Outcome #4

1. **Outcome Measures**

Studying The Interaction Of Photosynthesis, Genotype, And Environment To Improving Maize Production

Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

Development Of Rust-Resistant Lines For Illinois Soybean Growers

Not Reporting on this Outcome Measure

Outcome #6

1. **Outcome Measures**

Identification Of Nematode Pathogens Using DNA Sequencing

2. **Associated Institution Types**

- 1862 Research

3a. **Outcome Type:**

Change in Knowledge Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2014	0

3c. **Qualitative Outcome or Impact Statement**

Issue (Who cares and Why)
The initial goal was to develop a rapid approach to discover new viruses in plant parasitic nematodes. A method was developed to physically disrupt nematodes and then recover viral particles on a small scale. The ability to work with small volumes was critical since it is often hard to obtain large numbers of plant parasitic nematodes.

What has been done

We were able to obtain 21 different isolates of root-knot nematode and then applied the viral isolation method to the samples. Using a multiplex strategy, we were able to obtain over 150 million DNA sequences from the pooled nematode samples. The sequences were analyzed by comparing them to a database containing known viral proteins. The initial results showed very significant matches to seven viruses, indicating the root-knot nematodes may contain viruses. However, we now think the viruses may have been from insect eggs that contaminated the nematode preparation and not from the nematodes themselves. Even so, this project has been very successful and shows that viruses can be detected in pooled nematode samples using a fairly simple technique. It may also indicate that asexually reproducing nematode species [root-knot nematodes] may contain different viruses than sexually reproducing species [cyst nematodes].

Results

This approach to virus discovery could be applied to any nematode population either in the laboratory or in the field. Nematode viruses have only been recently discovered, thus this approach has the potential to rapidly identify new viral species. However, it also shows that great care must be taken to use very clean nematode samples to avoid false positives. The study of nematode viruses could be very important for understanding their impact on soil ecology, but also to control damaging plant nematode species. Viruses have never been used to kill parasitic nematode, thus it is well worth the effort to identify new virus species and then test them for their ability to kill plant nematodes. If successful this approach may generate a sustainable method to manage plant parasitic nematodes in Illinois and thought the world.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
205	Plant Management Systems
206	Basic Plant Biology
212	Diseases and Nematodes Affecting Plants

Outcome #7

1. Outcome Measures

Development Of Improved Soft Red Winter Wheat Varieties

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The development of improved winter wheat varieties adapted to Illinois will benefit farmers and consumers in Illinois and surrounding states. Development of disease-resistant, higher-yielding, high-quality, lodging-resistant varieties decreases the farmer's per unit cost of production by increasing the yield and quality of the product without increased costs. Control of diseases through the use of resistant varieties rather than through the use of fungicides is preferable because using fungicides increases input costs and fungicide use involves several risks, such as the risk of groundwater contamination and the risk of ineffective control because of weather limitations on timely application. Use of improved germplasm will benefit farmers in Illinois since resultant varieties may be well adapted in Illinois as well as in other states. Basic research studies on wheat will contribute to increased understanding of wheat genetics and development, increased efficiency in breeding and evaluation, and better methods of selection including molecular marker assisted selection. This project also performs service functions in the education of future plant breeders through evaluation of germplasm from other programs in the Uniform Eastern Soft Red Winter Wheat Nursery and evaluation of germplasm for resistance to wheat soil borne mosaic virus, scab, and barley yellow dwarf virus.

What has been done

In the 2013-14 growing season about 100 advanced experimental breeding lines were evaluated in replicated tests. About 400 preliminary breeding lines were evaluated. Selections were made based on yield, test weight, milling and baking quality, maturity, height, and resistance to Fusarium head blight [scab]. In addition, about 1,560 breeding lines were evaluated in single plots, and about 350 of these lines were selected for continued evaluation in 2015. About 26,000 F4 headrows were evaluated in 2014, and about 1,800 headrows were selected for further evaluation in 2015 based on height, maturity, disease resistance, and kernel morphology. Preliminary increase blocks of several experimental breeding lines were grown in 2014 in preparation for release of these lines.

Results

We used molecular markers for enrichment of FHB resistance genotypes in about 10 F2 populations. An association mapping study was conducted to identify wheat lines that are most likely to contribute genes to enhanced FHB resistance. Data were collected from about 100 advanced lines. High quality data were obtained from all four locations and used for selection of the best breeding lines. We collected data on grain yield, test weight, height, heading date, Fusarium head blight resistance, leaf blight, and grain quality.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
205	Plant Management Systems

206	Basic Plant Biology
212	Diseases and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #8

1. Outcome Measures

Evaluating The Effectiveness Of Cover Crops In Reducing Disease Severity

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Identification And Evaluation Of The Many Possible Functions Of Cover Crops

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Organic farmers have had some success using cover crops, rotary hoeing, and in-row cultivation during the grain crop growing season to suppress weed populations. But the successful use of tillage is weather-dependent, necessitating development of alternatives. While important for weed control, the extra time spent tilling can be economically and physically detrimental. Extensive tillage encourages organic matter decomposition, breaks down soil aggregates, weakens soil structure and can eventually lead to compaction. Not only are compacted soils physically difficult and costly to reverse, compaction has a multitude of negative consequences on soil quality and crop productivity. Compaction interferes with water infiltration, nutrient cycling, root development, and aeration which in turn can negatively affect crop growth and yield. Compacted soils in organic grain production present a serious issue to the efficiency and success of the system. The addition of cover crops has been proposed as a solution to soil compaction, and studies were started in Illinois to observe the effects of the addition of cover crops on organic grain production systems.

Research in other states has suggested that incorporating deep-rooted cover crops minimizes compaction and improves soil quality. Introducing deep rooted cover crops, such as forage radish, into organic grain production systems has the potential to alleviate compaction, improve soil quality, and suppress weed populations. Though the potential benefits from deep rooted cover crops are multiple, the results are highly dependent upon factors such as agronomic management, length of the growing season, plant species, subsequent cash crop, soil type, and weather conditions.

What has been done

Compaction did not have a significant influence on overall cover crop growth but did have an effect on spring weeds biomass. Spring weeds biomass was lowest for the non-compacted areas of forage radish, harry vetch, and cereal rye NCP FRhvr rotation, and FRhvr cover crop treatment did have the overall fewest number of weeds with 37% less than the control. The FRhvr rotation was the only treatment to reduce counts and biomass, but this effect was only witnessed in the first spring sampling time prior to seedbed preparation and planting. Weed suppression by cover crops was over then and the entire weed population as cover crop did not selectively suppress specific weed groups and did not influence weed diversity. Certain cover crop combinations can effectively control weeds in organic grain production, but trade-offs must be considered with their implementation. In harsh weather conditions, cover crops potentially compete with cash crops for water resources. The drought conditions in 2012 contributed to the 20% yield decrease in the FRhvr in NCP in comparison to the NCP control. This trend was verified with the scaled corn and soybean yields. Additionally, these results speak to the potential benefits of the compacted areas to help retain valuable water resources and improve cash crop growth.

Results

Overall, there is a need for more research in the organic grain sector. Cover crop research has been frequent in conventional systems, but few studies have focused on organic production. Our study shows that cover cropping acts as a great tool for weed management for farmers in the Midwest in organic grain production, but understanding the impact of the practice in variable weather conditions and in long-term systems is required. The benefits of this practice are greatly variable by location and management system so further research is needed in the Midwest in organic grain production systems to verify the potential of these cover crops.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
206	Basic Plant Biology
213	Weeds Affecting Plants

Outcome #10

1. Outcome Measures

Developing New Strategies For Controlling Fire Blight

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Fire blight, caused by the bacterial pathogen E. amylovora, is a destructive disease of apples and pears. In the United States, regional losses to fire blight and cost of control average over $100 million annually. The use of streptomycin, an antibiotic that targets the blossom blight phase, has been recommended until recent years when the occurrence of streptomycin resistance has rendered this antibiotic ineffective. Moreover, this also raises concerns over the potential impact of agricultural use of antibiotics on human health. Without streptomycin, there are no other reliable fire blight disease control measures available. Thus, new strategies for controlling fire blight are critical for preventing severe losses in susceptible orchards in the near-term along with pursuing strategies for long-term management of fire blight. Sigma factors, small RNA, and protein post-translational modification are part of the global regulatory networks in bacteria. Sigma factors, including alternative sigma factors, are essential transcription initiation factors that direct RNA polymerase to bind specific promoter regions. It is also known that many sRNAs are members of regulatory circuits involved in stress response, virulence, and metabolism.

Furthermore, it is well established that acetylation of proteins can influence their binding to DNA, thus impacting gene expression. However, for plant pathogenic bacteria, studies involving sigma factors, small RNA, and protein lysine acetylation have been very limited. Therefore, there is a critical need to conduct research in these new and emerging areas by determining the role of small RNA, sigma factors, and protein lysine acetylation in regulating virulence factors in E. amylovora. The knowledge gained will further improve our fundamental understanding of how E. amylovora infects hosts and causes disease, and allow us to develop strategies for disease control and for reducing the economic losses. The knowledge could also be extended to other enterobacterial systems such as E. coli and Salmonella, which are great threats to human health and food safety.

What has been done
We investigated the role of RpoN, a nitrogen limitation sigma factor, and its modulation protein YhbH, a novel ribosome-associated protein, in E. amylovora virulence. Our results showed that mutations in hrpS, hrpL, rpoN, and yhbH, but not yfiA and rmf3, resulted in nonpathogenic phenotype on immature pear fruits and apple shoots. Consistently, expression of T3SS genes including hrpL, dspE, hrpN, and hrpA was barely detected in hrpS, hrpL, rpoN, and yhbH mutants. These mutants were also not capable of eliciting hypersensitive response [HR] on tobacco. However, overexpression of hrpL using an inducible promoter rescued the HR-eliciting abilities of these mutants.

Results
Sigma factors, including alternative sigma factors, are essential transcription initiation factors that direct RNA polymerase to bind specific promoter regions. Our results suggest that a sigma factor cascade in E. amylovora exists in its regulatory networks and regulates important virulence factors. Based on this study and previously reported data, a model is proposed on regulation of T3SS in E. amylovora.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
206	Basic Plant Biology
212	Diseases and Nematodes Affecting Plants

Outcome #11

1. Outcome Measures

Increasing The Yield Potential And Pest Resistance Of Soybean Cultivars In Illinois

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

This research is important because soybean is the most important protein and oilseed crop in the world. The U.S. is the largest producer of soybean internationally with a production of over 90 million metric tons in 2011. The demand for soybean is expected to grow and the U.S. must continue to improve its soybean production efficiency to compete in the global market. These improvements include both increasing the yield potential and pest resistance of cultivars. Although research efforts in soybean breeding and genetics are in progress in many states, these efforts are needed in Illinois because each state has its own unique production environments and pest problems. The ultimate beneficiaries of this research are soybean producers who receive the technology developed through this effort in publicly and privately developed varieties.

What has been done

The University of Illinois soybean breeding program developed new experimental lines and tested lines for yield, agronomic traits, and disease and pest resistance during 2014. The program grew over 3,000 4-row yield test plots, over 6,600 2-row yield plots, and over 11,000 plant row plots. These plots were planted in field locations that include the main South Farm on the University of Illinois campus, the Northern Illinois Agronomy Research Center near Shabbona, the Brownstown Agronomy Research Center near Brownstown, and on land rented from farmers near Pontiac and Arthur [all in Illinois]. The most advanced lines from the program were evaluated in regional tests at locations throughout soybean growing regions in the north central and eastern U.S. Data from these tests are being analyzed and selections will be made to decide what lines will be tested in experiments planned for 2015. Those lines with the greatest yield and resistance over the past few years were selected and nine new potential cultivars were released to a cooperating seed producer for increase and potential commercialization. All nine are non-GMOs and could be useful in filling the need for non-GMO soybean cultivars.

Results

Progress has been made in research on resistance to soybean cyst nematodes [SCN]. Although over 118 soybean accessions have been identified as possible sources of resistance to SCN, most soybean cultivars in the Midwest have resistance that traces only to the PI 88788 resistance source. This reliance on a single resistance source has resulted in the selection of nematode populations that can overcome this resistance. Therefore, it is important to identify and evaluate novel SCN resistance genes. During the past year, we tested a combination of resistance genes that included a quantitative trait locus [QTL] from PI 567516C on chromosome [chr] 10, two resistance QTL from wild soybean [Glycine soja Siebold and Zucc.] accession PI 468916 on chr 15 and 18, and the rhg1 resistance gene from PI 88788. A population segregating for the four genes was tested with two nematode populations. The SCN resistance alleles from PI 88788, PI 468916, and PI 567516C significantly increased SCN resistance compared to the alternative alleles. Lines homozygous for the four resistance alleles had a lower female index [FI] than those homozygous for the susceptible alleles. These results indicate that combining multiple sources of resistance can be an effective means to increase SCN resistance.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
212	Diseases and Nematodes Affecting Plants

Outcome #12

1. Outcome Measures

Documenting The Occurrence And Distribution Of Herbicide-Resistant Weed Populations In Illinois

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The goal of this project is to quantify and document the occurrence and distribution of herbicide-resistant weed populations in Illinois. Specifically, the project will include the following activities: [1] Verification of herbicide resistance in putative herbicide resistant weed populations by utilizing field, greenhouse, and laboratory experiments to determine the sensitivity of the populations to herbicides from one or more sites of action; and [2] Collate and disseminate the research data to Illinois weed management practitioners who are responsible for making weed management decisions and recommendations.

What has been done
Palmer amaranth is a weed species that must be thoughtfully and carefully managed; simply attempting to control Palmer amaranth often leads to ineffective herbicide applications, substantial crop yield loss, and increasing weed infestations. Ignored or otherwise not effectively managed, Palmer amaranth can reduce corn and soybean yield to near zero. The threat of Palmer amaranth during the 2014 growing season was very real across a large portion of Illinois. We initiated field research experiments in 2014 to investigate herbicide options to manage Palmer amaranth in corn and soybean.

Results
Our results indicated many soil-applied active ingredients provided residual control of Palmer amaranth following application, but residual control rarely persisted for longer than 21 days after application. Foliar-applied herbicides that effectively controlled Palmer amaranth included glyphosate, glufosinate, dicamba, 2,4-D, HPPD inhibitors, and PPO inhibitors; however, the effectiveness of these herbicides was greatly dependent on the size of the Palmer amaranth

plants at the time of application. The greatest control was achieved when these products were applied to plants 7 cm tall or less; control was reduced when application was made to plants taller than 7 cm. Anecdotal observations on the emergence of Palmer amaranth plants indicated the first emergence event occurred during the first week of May in 2014, and subsequent emergence events were noted throughout much the growing season, continuing at least through August. These field experiments constituted our first field research efforts with Palmer amaranth in Illinois.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
206	Basic Plant Biology
213	Weeds Affecting Plants

Outcome #13

1. Outcome Measures

Determining The Reproductive Stage At Which Weeds Can Be Terminated And Still Produce Viable Seed

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Our objective is to determine the reproductive stage at which weeds can be terminated and still produce viable seed.

What has been done
In December 2013 seed counts, viability and germination were determined. Velvetleaf terminated at first flowering did not produce any seed, probably because the flowers were not adequately developed to produce seed. Velvetleaf terminated 10 days after flowering produced greater than 300 seeds/plant. Only in the velvetleaf terminated with glyphosate were viable seed produced but germination was slight possibly due to seed dormancy. Redroot pigweed plants produced upwards of 3,000 seeds but none of the seeds were viable [probably due to inadequate

carbohydrate reserves available to complete seed development]. Canada thistle produced the most seed in the glyphosate termination at flowering, probably because of its ability to mobilize carbohydrate reserves from its perennial root system. Although some seeds were viable, few seeds germinated.

Results

Our conclusion is that seed can develop on weeds after termination of growth either by chopping or glyphosate treatment. The message to farmers is that they need to control redroot pigweed, Canada thistle, and velvetleaf before emergence or when small and that rescue treatment should be done before the plants start flowering. This spring we established the experiment again. The termination times were at first flowering or ten days after first flowering. One half of the plants were cut at the base to simulate hand hoeing and the other half of the plants treated with a 2% solution of glyphosate with ammonium sulphate. At termination we measured height of the plants and harvested the plants cut at the base. Immediately after harvesting the cut plants were placed in nylon mesh bags. We let the glyphosate-treated plants remain standing until late September but covered them with nylon mesh bags tied at the base to retain any seed. After harvesting the plants were placed between soybean rows until late November and then brought in. The plants terminated at first flower range from 46 cm for Canada thistle to 81 cm for velvetleaf. The plants harvested at 10 days after first flowering ranged in size from 51 cm for Canada thistle to 91 cm.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
213	Weeds Affecting Plants

Outcome #14

1. Outcome Measures

Assessing The Effects Of Various Stresses On Crop Yield And Quality

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2014 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The problems addressed by this research are assignable to one of two categories: [1] Assessing new technologies, including determination of optimal input rates where appropriate; and [2] Assessing the effects of various stresses on crop yield and quality. Achieving and maintaining high crop yields is at the heart of competitiveness of Illinois agriculture in the nation and the world. With outstanding soil and human resources, Illinois is well-positioned to maintain its preeminence among crop-producing states. But in order to accomplish this, management practices must constantly be adjusted to reflect changes in cultivars, markets, and available technology. One practice that has gained widespread acceptance in recent years is the use of foliar fungicides on corn [and to a lesser extent on soybean], not only to manage developing fungal diseases, but also to maintain 'plant health' [a euphemism for physiological effects] and thereby increase yield [particularly when the crop is under stress]. Our preliminary work has produced mixed results, with no consistent increase in yield when disease pressure is low or absent. We simply must have better answers to guide the use of a costly practice that counters the IPM approach to management.

This project will help provide solid answers to real questions that farmers continue to face as they adjust to new demands and opportunities in grain crop production. New options must be evaluated and optimum practices determined in order to prevent deterioration in the state's competitive advantage in grain crop production efficiency. Public welfare is directly increased when farmers, informed about technological options, can make decisions that increase efficiency, stabilize production, and lower food costs. This project will produce information needed to bring this about. At the same time farmers receive this information, publication in scientific journals will assure that this knowledge is available to the scientific community.

What has been done

The 2014 crop year was outstanding, with timely planting of both corn and soybean, below-normal temperatures in July, and little crop stress. Average state corn yield in 2014 is estimated at 12.5 t/ha and soybean yield at 3.8 t/ha, both record highs. Responses to planting date were fairly typical compared to those in recent years. At the northernmost three sites [DeKalb, Monmouth, and Urbana], yields at the earliest planting dates [the first half of April] were highest, and dropped relatively slowly as planting was delayed through mid-May. By the last date in late May yields had dropped by 12 to 18%, close to the predicted loss of yield based on previous work. At the three southern Illinois sites, first planting dates tended to experience stand problems due to wet soils and [at Perry] frost after planting, and the second planting date [in late April or early May] produced the highest yields. At these sites, yield loss from planting in early to mid-June ranged from 25 to 40%. Highest yields averaged 14.5 t/ha among the three northern sites and 12.1 t/ha at the three southern sites [all are higher than normal]. Foliar fungicide increased yield significantly at the DeKalb and Urbana sites, by 4 and 2%, respectively. There was no interaction between fungicide and planting date at either of these sites.

Results

Soybean planting date x row spacing [38 and 76 cm] x foliar fungicide/insecticide studies at five sites produced results similar to those with corn, but with a larger decline as planting was delayed compared to corn. Across four sites in central and northern Illinois, yields dropped from 4.8 t/ha at

an average planting date of April 23 to 4.3, 4.1, and 3.7 t/ha at average planting dates of May 10, May 25, and June 11, respectively. This change from early to late compares to previous decreases, but the decrease in 2014 was more linear, with losses per day as high early in the planting period as in the late planting period. Three of these four sites showed a significant yield increase from the use of foliar fungicide and insecticide, with the average over planting dates of 0.3 t/ha, or 6%. At none of these sites did the response to fungicide interact with planting date; the expectation that planting date will influence the development of diseases controlled by fungicide has seldom been demonstrated in this project. At two of these four sites, yield responded to narrow rows, with an average yield increase of 8%.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
206	Basic Plant Biology
212	Diseases and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #15

1. Outcome Measures

Determining The Role Of Root Architecture On Abiotic Stress Tolerance In Maize

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Despite significant advances in maize genomics and the development of maize cultivars with improved levels of drought tolerance, the underpinning physiological processes and their consequences for whole plant function are not well understood. Roots are of key importance in water acquisition but the role of root structure and its relationship to drought tolerance is also not well investigated. In this study we examine the dynamics of biomass production and biomass partitioning of maize hybrids with very different root architectural characteristics if exposed to

drought at the beginning of their reproductive phase. This developmental stage of maize is particularly sensitive to drought and subsequent yield loss. We envision that knowledge of the dynamic crop physiological processes that determine drought tolerance and are potentially related to differences in root architecture will provide corn breeders with more targeted selection criteria and molecular biologists with more relevant genomic targets.

What has been done
Across all three root studies focusing on biomass partitioning, drought response, and nitrogen response, maize hybrids with high-complexity root systems produced more biomass overall than the low-complexity root system hybrids. This is likely due to the ability of this root system to more immediately capture resources like water and fertilizer in optimal conditions, as seen in the biomass partitioning study, and nitrogen added conditions. In the case of the drought response study, this root system likely allowed better resource capture prior to initiation of drought, thus leading to overall more biomass being produced. Hybrids with low complexity root systems also plateaued, LH82*PHJ40, or even declined, PHG47*PHJ40 and B73*PHJ40, after the V15 stage when looking at the amount of leaf area. From this, it can be speculated that this set of hybrids partitions its resources in such a way that after flowering there is less emphasis on developing or sustaining vegetative biomass.

Results
Under water-limited conditions, low root complexity hybrids yielded higher than high root complexity hybrids. This is likely due to the fact that the root system as a whole was smaller but had a steeper root angle, allowing deeper soil exploration for water and fewer resources allocated to the root system and maintenance of the root system. Low root complexity hybrids also had less drastic rates of increase in leaf area accumulation after the R1/R2 growth stage than the high-complexity hybrids in the water limited conditions. This seems to indicate that these hybrids are partitioning fewer resources to the vegetative organs and, therefore, are better able to produce an appreciable amount of kernels during reproductive development when water is withheld during flowering. Under conditions with no added nitrogen, all hybrids had the same yield, but hybrids with high-complexity root systems had greater overall biomass. However, with added nitrogen, high-complexity hybrids yielded significantly higher. This is likely due to the architecture and complexity of these root systems allowing rapid acquisition of the added nitrogen before it could be converted into plant-inaccessible forms or leached into deeper soil layers. In the nitrogen response study, at a rate of 252 kg/ha added, a similar leaf area production trend was seen as in the water-withheld treatment of the drought response study in that low-complexity hybrids tended to have a less steep increase in leaf area near the time of flowering. However, unlike the drought response study, the low-complexity hybrids yielded less under high nitrogen. This seems to indicate that under non-limited conditions, the increased LA allows better grain fill which would be related to the proposed advantage in resource capture by high complexity root systems. When no nitrogen was added we again saw that two low-complexity hybrids, LH82*PHJ40 and PHG47*PHJ40, plateaued with respect to the amount of LA produced around flowering. This did not relate to any yield advantage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems

206 Basic Plant Biology

Outcome #16

1. Outcome Measures

Investigating The Impact Of Elevated CO2 And O3 On Soybeans

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Dramatic atmospheric alterations have occurred during the past several decades that may have a serious impact on agriculture. Elevated ozone has been estimated to amount to a loss of agricultural productivity of as much as $3 billion yearly in the U.S. and Canada. Carbon dioxide [CO2] and ozone [O3] are increasing steadily in the atmosphere and are expected to double from pre-industrial levels by the end of the 21st century. Elevations of CO2 and O3 have been associated with multiple negative impacts on plants. Ozone is considered one of the most toxic pollutants in the troposphere and soybeans are one of the most sensitive plants to O3 damage. Responses of soybean plants to elevated CO2 and O3 include increased photosynthesis [as a result of elevated CO2] and thus enhanced yield, balanced by decreased yield caused by elevated O3.

What has been done
The University of Illinois has the perfect opportunity to investigate the impact of elevated CO2 and O3 on soybeans, the largest single source of protein meal and vegetable oil in the human diet. We have the only free air gas concentration environment [FACE] facility in the world that has been established to study the impact of altered CO2 and O3 on the soybean crop [the SOYFACE facility]. Soybeans serve as a significant source of biologically-important compounds, the alteration of which could have significant impacts on product quality and human health. We will study the impact of these growth conditions on the food quality and nutritional value of soybeans as well as on the ability of soybean plants to adapt to the atmospheres of the future. One of the impacts will be the ability to select soybeans to meet the needs of consumers for growth under these altered conditions.

Results
Our oilseed research is focused on responses of soybeans to growth under elevated ozone and carbon dioxide. Soybean composition is greatly impacted by growth under these different environmental conditions, and there are dramatically different outcomes depending on the cultivar of soybeans under investigation. Observation of fatty acid profiles and correlation with isoflavones led to the result of a negative correlation of oleic acid with total isoflavones [and with two major isoflavones, genestin and daidzin]. This together with the fact that oleic acid is indicated as a potential key signaling compound of plant defense [with salicylic and jasmonic acid synthesis] indicates that oleic acid may also play a role in control of isoflavone production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
206	Basic Plant Biology

Outcome #17

1. Outcome Measures

Number Of Individuals Increasing Knowledge Related To Detecting And Managing Invasive Pests

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	141

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Emerging pathogens and insects can cause serious damage and loss to Illinois trees if not detected early, resulting in economic and environmental consequences related to treatment or replacement.

What has been done
One-day First Detector programs were again offered at six locations in Illinois focused on training tree care professionals, Master Gardeners, Master Naturalists, forestry and natural resource

professionals, and conservationists. Training focused on : [1] Increasing their awareness of emerging and current oak problems in Illinois [Oak Splendor Beetle, Goldspotted Oak Borer, European Oak Borer, and Sudden Oak Death] and invasive plants introduced as ornamentals [Burning Bush, Bradford Pear, and Japanese Barberry]; [2] Reducing potential risks from these pathogens, pests, and plants; and [3] Increasing knowledge of plant diagnostic support. Extension specialists delivered course elements for each pest that included: [1] Identification/detection; [2] Life cycle/biology; [3] Hosts; [4] Sampling; [5] Management; [6] Commonly confused look-alikes; and [7] Regulation. Following the training 108 of the 175 participants completed an evaluation that asked them to compare their degree of understanding of these topics before and after the training sessions using a 1 to 5 scale [1=very little, 5=a lot].

In addition, the two IPM modules developed and released this past year to increase Master Gardeners' knowledge about gypsy moths and oak problems provided them with continuing education opportunities. When finished with a module, participants took a short quiz and completed an evaluation before being able to print a certificate of completion.

Results

With respect to knowledge related to Sudden Oak Death, all but one of the 108 [99.1%] evaluation respondents increased their degree of understanding regarding at least one of the six topics. Based on an average group rating score on each topic before and after the training, a comparison of the scores revealed that the topic that generated the greatest change in knowledge [121.5%] was 'commonly confused look-alikes' followed by 'sampling' [118.9%], 'life cycle/biology' [108.1%] and 'management' [104.5%]. Changes in knowledge of Sudden Oak Death 'identification/detection' and 'hosts' were 95.7% and 82.6% respectively. It is worth noting that all scores for these topics were above 3.69 after the training as compared to 2.08 and below before the training.

When reviewing the knowledge areas for Invasive Oak Insects, the before training average group scores for topics related to this pest ranged from 2.09-2.28 and after training scores ranged from 3.80-3.99. However, percentage changes in knowledge of the topics were lower for these Oak insect pests ranging from 71.5% [detection and symptoms] to 81.4% [life cycle/biology]. These findings are not surprising based on the more recent discovery of these pests. Ninety-seven percent [105 of 108] increased their degree of understanding in at least one of the Invasive Oak Insect topics.

For the Invasive Ornamental Plants, a comparison of group ratings for degree of knowledge change revealed a 39.7% increase by 91 of 108 [84.3%] participants. When asked to indicate the number of people they encounter in regard to tree care, as many as 25,050 people could be reached by these trained First Detectors.

Responses to the IPM modules evaluation [which used a rating scale of 1=low to 5=high] indicated that the 39 individuals who complete the Gypsy Moth module reported a 53% average increase in knowledge of this insect pest after completing the module. Results for the Oak Problems module were somewhat lower for the 30 individuals who completed the evaluation [a 47% average increase in knowledge of the pathogen].

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Diseases and Nematodes Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Master Gardener Evaluation Study

A study with slight modifications to the evaluation instrument used in 2007 and 2012 was conducted in 2014 with Master Gardeners who had 2-4 years of experience. The online evaluation was designed by the state coordinator of Master Gardeners who asked county Extension coordinators to send a prepared email to these newest Master Gardeners inviting them to participate in the survey. The survey addressed perceived changes in 13 practices, 11 personal improvement skills, and experience in teaching horticulture topics.

The first set of findings was based on two questions that asked respondents to indicate their use of 13 gardening practices before and after becoming a University of Illinois Master Gardener. It should be noted that all but 14 of the 269 respondents indicated an increase in at least one or more of the recommended gardening practices. Results follow.

71.4% [192 of 269] now prune landscape plants properly.

69.9% [188] now identify an insect, disease or weed problem before deciding on a control measure.

66.9% [180] now chose plant varieties that are known to be resistant to insects and diseases.

53.5% [144] now choose landscape plants based on the conditions of the planting site.

52.0% [140] now use water saving strategies in the garden.

51.3% [138] now take soil tests.

51.3% [138] now mulch landscape plants properly.

50.6% [136] now keep records of pest occurrence for later reference.

49.4% [133] now follow recommendations on soil test reports.

49.4% [133] now keep records of results of control methods for later reference.

45.0% [121] now install landscape plants properly.

36.8% [99] now recycle organic materials in the yard through mulching and composting.

27.9% [75] now use pesticides only according to the directions on the label.

The second set of questions addressed frequency in teaching the above gardening practices to others. Response choices included 'Almost never', 'Occasionally', 'Often', 'Very often', and 'Don't know'. Approximately one fourth of the respondents [62] indicated that they had occasionally, often, or very often taught all thirteen topic areas. The topics 'Often' or 'Very often' taught include the following:

64.7% [174 of 269] taught mulching landscape plants properly.

61.3% [165] taught installing landscape plants properly.

60.2% [162] taught choosing landscape plants based on the conditions in the planting site.

58.7% [158] taught recycling organic materials in the yard through mulching and composting.

57.2% [154] taught choosing plant varieties that are known to be resistant to insects and diseases.

56.1% [151] taught pruning landscape plants properly.

53.9% [145] taught identifying an insect, disease or weed problem before deciding on a control measure.

50.9% [137] taught using water saving strategies in the garden.

49.4% [133] taught using pesticides only according to the directions on the label.

A third set of questions was developed to assess the Master Gardener's perceptions in changes related to 11 skills for working with others. Response options to each skill included 'Not at all', 'Slightly', 'Moderately', 'Much', and 'A great deal'. Of the 235 who answered this question, 82.6% indicated that their skills for one of more of those listed had improved 'Much' or 'A great deal'. Skills improvement rated 'Much' or 'A great deal' follow in order of frequency:

70.6% [166 of 235] increased their skill in solving gardening problems.

66.8% [157] acquired information better.

44.7% [105] indicated they were willing to accept more challenges.

37.0% [87] gained skill in communicating more effectively with others.

36.2% [85] increased skills in working more productively with a group.

36.2% [85] indicated setting goals more effectively.

36.2% [85] could reach goals more effectively.

27.7% [65] could speak to a group more effectively.

26.4% [62] could lead a group more effectively.

23.4% [55] gained skill in delegating responsibilities within a group.

13.6% [32] improved computer skills.

Key Items of Evaluation

Master Gardener Evaluation Key Finding

Ninety-five percent [255] of the **Master Gardeners** indicated an increase in at least one or more of the recommended gardening practices after participating in their training. More than two-thirds now prune landscape plants properly, identify an insect, disease or weed problem before deciding on a control measure, and choose plant varieties that are known to be resistant to insects and diseases. Since these Master Gardeners teach others, their outreach likely has a similar effect on the practices of those they reach [including more than 164,000 face-to-face teaching contacts in 2014]. In addition, University of Illinois Extension has contributed to effectively building skills that will enhance the Master Gardener's teaching and leadership to serve both individuals and communities.