V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Plant and Animal Protection

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
211	Insects, Mites, and Other Arthropods Affecting Plants	10%		10%	
212	Pathogens and Nematodes Affecting Plants	25%		25%	
213	Weeds Affecting Plants	20%		20%	
215	Biological Control of Pests Affecting Plants	5%		5%	
216	Integrated Pest Management Systems	20%		20%	
312	External Parasites and Pests of Animals	5%		5%	
315	Animal Welfare/Well-Being and Protection	15%		15%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2010	Extension		Research	
	1862	1890	1862	1890
Plan	1.8	0.0	11.2	0.0
Actual	5.0	0.0	9.3	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**
479732	0	442429	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
479732	0	442429	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

An ELISA technique was adapted and used to quantify titer concentrations of imidacloprid in foliage of commercial pecan orchards. Imidacloprid titer concentrations in pecan leaf and blackmargined aphid (Monellia caryella) population density measurements determined aphid resistance to imidacloprid in commercial orchards continue to increase. Results from leaf-dip studies determined that blackmargined aphid resistance levels have increased 8x from 2009 to 2010. Foliar efficacy studies support laboratory findings of increased imidacloprid resistance in western pecan aphids. A collaborative research effort was initiated during the reporting period to identify the primary mechanisms in blackmargined aphid responsible for imidacloprid resistance. Traditional primers used to identify specific insecticide resistance mechanisms in other aphid species were not successful when used on blackmargined aphid. A search for primers that will successfully isolate specific DNA or RNA areas linked to imidacloprid resistance mechanisms continues. During the reporting period a caged and non-caged replicated field study was conducted to evaluate the impact of registered and candidate insecticides on changes in thrips species in onions. In general, early season thrips populations in onions are comprised primarily of western flower thrips (Frankliniella occidentalis) with the percentage of onion thrips (Thrips tabaci) increasing as the growing season progresses. Results have yet to be analyzed.

Diorhabda elongata from Crete is established in several locations on the Pecos River near Artesia, NM. Monitoring of beetle dispersal and defoliation was conducted in 2010. Due to federal restrictions, beetles have not been moved from successful sites on the Pecos to new sites. D. carinulata from Fukang, China, established in UT and CO, have established in NW NM near Shiprock and Farmington and defoliated several thousand acres in 2010. Rhinocyllus conicus, is well-established in NM on musk thistle. Experiments to determine the impact of this beetle on the endangered Sacramento Mountains Thistle (Cirsium vinaceum) began in 2007-08. Where present, R. conicus oviposited on 95% of the musk thistle seed heads compared to 69% of the C. vinaceum seed heads. Post seed maturation evidence of R. conicus development suggests weevils may not develop well on C. vinaceum, probably due to competition with the native weevil, Lixus pervestitus and the native tephridid, Paracantha gentilis, which all but eliminated seed production at several sites. Tetrashicus spp. are chalcidoid wasps released to parasitize elm leaf beetle eggs. We investigated if Tetrastichus spp. would parasitize Diorhabda spp., an important biological control agent for saltcedar. When wasps were confined in small cup arenas, parasitization rates were 93.3% at densities of two Tetrastichus spp. wasps per egg cluster and 87% at densities of one wasp per egg cluster. Parasitization of clusters resulted in 28.4 wasps emerging per cup. When comparing the rates of parasitization separately, Tetrastichus spp. parasitized only 33.3% of the X. luteola egg clusters whereas Tetrastichus spp. parasitized 77% of Diorhabda spp. egg clusters. A choice test study between X. luteola and Diorhabda spp. had a mean of 31 wasps hatching from Diorhabda spp. eggs compared to a mean of 2.5 wasps emerging from X. luteola eggs. In a sleeve cage test on a branch of saltcedar, Tetrastichus spp. parasitized 60% of Diorhabda spp. egg clusters with an average of 3.27 wasps per egg cluster. While laboratory studies demonstrate that Tetrastichus spp. will parasitize Diorhabda spp. eggs, field tests are needed to confirm our results. We tested survival, development rate, and egg production of laboratory-fed Diorhabda on saltcedar foliage from trees that had been grown under a range of fertilizer treatments. Tissue samples from experimental trees and from the field were analyzed for % N, P, and K. Beetle larvae did not survive when fed foliage from saltcedar trees at N levels <2.0%. At levels >2.0% nitrogen, beetle larvae had increased survival rates and shorter development times. Multiple regression analyses indicated that N and P are important for larval survival and faster development rates. Higher levels of K were important for increased egg cluster production. Plant tissue analysis showed that the %N in experimental trees reflected the range of trees in the field and also that there is high variability within trees in the field. Research indicates that if beetles are released in cages on trees with poor nutrient

quality, the larvae will not survive. PARTICIPANTS: Nothing significant to report during this reporting period.

Since there was no multiple-resistance to tested alternative mode of action herbicides in the glyphosate-resistant population; therefore, these herbicides could serve as effective alternatives for control of this glyphosate-resistant Palmer amaranth population in New Mexico. Our field trials indicated that in pecan orchards, season long weed management can be achieved by Pre-emergence herbicide combinations. These alternative treatments will not only provide acceptable control of current glyphosate-resistant palmer amaranth populations but also will reduce the number of herbicide applications per growing season.We believe that this study will increase growers and our understanding of the ecology of weeds and plant pathogens under various treatments and under field conditions. Furthermore, this study will improve our current knowledge of seasonal (short-term) and long-term variability of soil microbial biomass and their co-relation to various pest control treatments in organic agriculture. We expect that the use of cover crops with allelopathic compounds together with mechanical weed control measures (i.e., conservation tillage, wheat straw mulch) will increase short- and long-term weed and pathogen control in the fields. Effective short- (seasonal) and long-term (seedbank dynamics) weed management strategies that are environmentally and economically sound and will be evaluated in this study will enhance the profitability of organic agriculture by reducing the labor and fertilizer cost, at the same time will increase the sustainability of organic systems through soil, water and fertilizer conservations.

A study was conducted to determine the susceptibility of a field-collected house fly strain to both commercially-available and experimental insecticidal granular baits. This study was undertaken as part of the Control and Resistance Management Tactics objective of multistate project S-1030. House flies were evaluated in an arena containing either commercial or experimental fly baits. The experimental bait performed similarly to the commercial baits resulting in 100% house fly mortality at the end of the study. However, the results demonstrated that control using the experimental product is slower and allows for multiple feedings prior to death. Therefore, many house flies consuming this bait will likely expire at sites other than the bait station location. This may lead to a misperception of efficacy and a reduced rate of adoption by industry. However, this new formulation may help delay house fly resistance development in field populations if adopted as part of a management program.

Results of greenhouse and microplot experiments to identify relationships between weeds, Verticillium, and root-knot nematodes emphasizes the importance of weed control in chile pepper fields; not only to reduce the impact of weed competition on yields, but to reduce the impact of diseases. Nematode reproduction levels were similar among chile, tall morningglory and Wright's groundcherry in greenhouse studies. Spurred anoda was a poorer host for Mi than the other species in both experiments. Co-infection with Verticillium had little effect on nematode reproduction in these experiments. These results demonstrate that all three weeds will support both pathogens, alone or in combination, without suffering pathogenic effects, and that tall morningglory and Wright's groundcherry support levels of M. incognita reproduction similar to those found in highly-susceptible chile plants. Effective management of these weeds may help reduce populations of both pathogens in future crops. Root-knot nematode resistant alfalfa has been shown to effectively suppress the nutsedge/nematode complex for a season after termination of the alfalfa. However, not all growers can produce alfalfa due to equipment needs or concerns about water availability from year to year. If we can identify cost effective, annual crop rotations that also suppress this pest complex, growers will have an additional, sustainable option for pest suppression in fields infested with these pests. Urban landscapes and crop production land in arid New Mexico are dependent on irrigation water supplied by compacted earthen canals and laterals either continuously or intermittently throughout the nine month irrigation season. Equisetum hyemale is becoming an increasing problem on the canals, using water intended for irrigation and obstructing water flow in irrigation canals. Effective management of this species is impossible without determining factors that influence its spread on the canals.

Etiological studies were conducted to determine the causal agents of (i) headrot on sunflower in New Mexico, and (ii) fruit rot (anthracnose) of chile pepper. Rhizopus oryzae was determined to the causal agent of headrot in sunflower. On chile pepper, the predominant fungal microorganisms associated with anthracnose on pepper fruit were Colletotrichum coccodes and Colletotrichum capsici.The impact of this research is that it provides New Mexico sunflower and chile pepper producers with information on emerging diseases, and should be useful information in preparedness for disease control in production systems.

In alfalfa, several projects are various stages of completion. We continue work on the seasonal phenology of the alfalfa weevil. Work also continues on alfalfa weevil strains in NM (with Steve Hanson) and document distribution, and biology of the pest, and are working on the problem of strain hybridization. We have completed a project on the comparative development of the alfalfa weevil strains in the laboratory. This work is the first to compare the development of all three U.S. strain under identical environmental conditions. It also compares individual feeding potential among late-instar larvae. We have created a preliminary list of the blister beetles of New Mexico. Currently, we have found ~70 species of blister beetles in the state, only 7 found in alfalfa. A more extensive study to evaluate cantharidin levels of several species of blister beetle was completed. Additional species will be added this coming year to determine potential toxicity.

We have completed field research on the impact of Lygus feeding on chile (w/ Brad Lewis). This research documents the external and internal signs of Lygus injury (both nymph and adult) to various stages of chile fruit. We have completed our research on the seasonal development of the beet leafhopper (vector of curly top virus) on weed host species (w/ Jill Schroeder and Rebecca Creamer). This project will determine the number of generations and timing of life stages of the beet leafhopper in New Mexico, as well as an evaluation of environmental factors that potentially influence leafhopper abundance (see additional report). A project this year is evaluating desert hosts to determine development of beet leafhoppers on these species as non-agricultural hostsWe have also conducted a field study on the species composition and seasonal development of flea beetles in chile over the last two seasons. These insects are very important early season defoliators of chile and no information is available on these pests in the state.

In cotton, several projects are being finalized on the impact of the western tarnished plant bug (Lygus) to New Mexico cotton. One experiment evaluated feeding injury by nymph (4th and 5th instar) and adult on individual developing squares and bolls. In another experiment, we are trying to determine economic injury levels for Lygus for New Mexico cotton. This research involves whole plant isolation of various levels (0-10 per plant) of nymph and adult Lygus to determine bug levels causing economic loss. We are also working closely with the USDA Cotton Ginning Laboratory (Paul Funk) to determine the impact of thermal defoliation on late-season insect pests causing "sticky" cotton. Our field research shows that thermal defoliation results in a significant, near-immediate termination of silverleaf whitefly populations -the worst cause of sticky cotton in the US. We have completed laboratory experiments to determine the thermal upper limits of silverleaf whitefly survival.

We have our research on the discovery of a red morph of the stink bug Mecidea minor in southern New Mexico. We also have determined the seasonal phenology and described the immature stages of this species. We currently are working on the morphology of Corimelaena incognita, and its relationship with segment fate in adult Heteroptera, and describing the immature stages of M. major.

Three parasitoids were successfully established in New Mexico. Two species are responsible for virtually all of the biological control of alfalfa weevil in southern New Mexico. Oomyzus incertus is responsible for approximately 40% of the control of alfalfa weevil in the Mesilla Valley. O. incertus and Bathyplectes spp. together often produce 70-80% control. In the Pecos Valley, O. incertus has been rare, and control of alfalfa weevil highly variable. The success of O. incertus in the Mesilla Valley suggested that

it could be successful elsewhere. Similar control would save growers in the Pecos Valley over $600,000 per year. In NM over $1 Million per year would be saved. Additional savings would be found in increased yields and reduced insecticide applications for secondary pests. O. incertus field nurseries were established in five counties at NMSU and commercial farms. We have detected O. incertus up to 10 miles from a field insectary in south Eddy County indicating that it is becoming successfully established. A number of field trials over four years were conducted on experiment station and commercial farms to determine how much impact alfalfa has on predation in pecan and cotton. Predation rates are generally high, but can be affected by distance from hay and by direction impacted by prevailing winds. Degree of predation is closely correlated with predator numbers and time of year. Cutting hay results in lower predation in nearby cotton. Data from these trials suggest that cotton relies on relatively constant immigration of predators from hay, emphasizing the importance of hay in pest management for all SE NM crops. Field trials conducted for 3 years evaluated the impact of tree size on predation of sentinel lepidopteran eggs in pecan. These trials in 3 locations over 80 miles and multiple time points from May to October indicated differences in the levels of predation by chewing vs sucking predators in small vs well established trees. Similar differences were found in borders vs interiors of orchards. Direct observation and collection of predators of sentinel eggs indicated that a spider, Hibana incursa is the most prevalent predator in pecan in the lower Pecos Valley. Yield partitioning and compensation testing in cotton indicate bollworm is rarely an economic pest in New Mexico. Bolls produced late season, most commonly lost as squares, have low value, primarily due to low natural retention, producing few bolls /acre on the later nodes. Cotton has the ability compensate by retaining squares or bolls that the plant otherwise would have shed. Less frequently, cotton can compensate by increasing lint per lock in bolls. Lower seed germination and lower lint quality in late season bolls further reduces their value. Late season boll losses on the other hand, are more of a concern, directly impacting yield. Compensation rates for early season square losses from pests like lygus are also high.

Beet leafhopper populations were evaluated each week in southern New Mexico at multiple locations fromJanuary 2008 through December 2009. Sampling consisted of weekly sweep and bucket samples and plant stem/leaf samples to determine adult/nymph and egg populations, respectively. Based on field research consisting of weekly samples over nearly two years, we found that the beet leafhopper completes 1 distinct generation (and a possible 2nd) on weedy hosts in southern New Mexico; this is considerably fewer generations than previously speculated in the literature. Our data gave us an excellent picture of the timing of adult and nymphal populations, as well as egg laying periods. We have shown that the beet leafhopper will complete its development on the weeds London rocket and kochia, confirming that these weeds are important hosts of the leafhopper. Evaluations of of site characteristics upon C. tenellus populations showed that nymph presence was found to be greater in fallow field type sites containing larger patches of weeds. The results of this research will provide New Mexico growers with critical information on the associations among the beet leafhopper, beet curly top virus, and key weed populations and the seasonal timing of these associations, providing management tools to better deal with this pest complex. Our data on the timing of leafhopper generations and developmental timing within generations and the relationship to plant phenology and host suitability are key to developing a management strategy. This combination of data give us a better starting point for managing the key weeds in the system and resulting leafhopper/virus populations. London rocket appears key to managing the system. Seedlings begin development in the fall and beet leafhoppers are ovipositing in late winter. Therefore, the weed should be targeted in fall while it still may be managed and before the leafhoppers have a change to build populations.

Our research on curly top virus focuses on the ecology, epidemiology and management of the disease caused by the virus in chile. We identified plant tolerance in peppers against curly top virus infection and developed tools to help characterize the nature of tolerance in tomatoes and peppers. Our research on fungal endophytes of locoweed has made progress toward characterization of endophytes from locoweeds throughout the western US. We concluded a study that assessed the effect of deleting a gene suscpected to be in the swainsonine catabolic pathway in Undifilum endophytes. Knockout of

saccharopine reductase caused increases in the levels of swainsonine and pipecolic acid, confirming the role of the enzyme in the pathway. Understanding more about the ecology, genetics, transmission, and weed hosts of beet curly top virus in New Mexico will aid in developing management options for chile growers. Our predictive model for curly top in southern New Mexico has given growers information on the disease so that they can make informed choices on which management methods they will need to use to handle the disease pressure. The information on virus-tolerant plants provides growers with several pepper types that can be grown without significant disease losses. A better understanding of the role that the fungal endophytes of locoweed play in locoism, the genetics of the fungi, and the factors that influence toxin production will lead to new options to mitigate the disease locoism and its impact. The information generated thus far changed knowledge significantly, in that nothing has been known about the mechanism by which the fungus produces the toxin.

- 14 youth oriented activities resulted in 14,000 students gaining knowledge in plant, and animal protection.

- 97% of IPM trained producers recognize the importance of gained knowledge and how it directly impacts their homes and jobs.

- 750 Master Gardeners and garden club members felt 80% empowered to assess and treat their pest problems after attending educational IPM seminars.

- CEU trainings for New Mexico pesticide operators resulted in an economic impact of $25,330,000 million.

- 96% increase in knowledge among North-Central New Mexicans in insect identification after attending educational workshops.

- Integrated pest managements programs are being developed in Northern New Mexico to control and manage prairie dog and elk populations.

- 98% of 200 participants in the Master Gardener weed identification and management training program reported training courses changed and enriched their understanding of weed identification and management issues.

- 99% of participants in the New Mexico Master Gardener program indicated learning something new about IPM from educational presentations.

- 96 producers from 10 counties participated in pesticide resistance workshops; 86% reported learning something new from the presentations.

- Direct information/training on IPM practices resulted in decreased use of insecticide for cotton bollworm.

2. Brief description of the target audience

Attention will be given to commodity organizations in or serving New Mexico producers as well as pesticide applicators, Master Gardeners and garden clubs, youth (4H, Future Farmers of America and other groups and conferences) and the general public.

V(E). Planned Program (Outputs)

1. Standard output measures

2010	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2010
Plan: 0
Actual: {No Data

Patents listed
{No Data Entered}

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Plan	2	3	
Actual	2	3	0

V(F). State Defined Outputs

Output Target

<u>Output #1</u>

Output Measure

- The specific output measures will vary according to the specific project being monitored. The development of research procedures and technology, training of students, publishing research papers, and disseminating research results via educational workshops, conferences, and Extension media are important outputs for the various projects falling under this planned program.

Year	Target	Actual

2010	0	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	# of trained professionals
2	# of research publications
3	# of Extension publications
4	% producers adopting NMSU recommendations to protect plants and animals

Outcome #1

1. Outcome Measures

of trained professionals

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	2	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
312	External Parasites and Pests of Animals
315	Animal Welfare/Well-Being and Protection

Outcome #2

1. Outcome Measures

of research publications

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	3	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
312	External Parasites and Pests of Animals
315	Animal Welfare/Well-Being and Protection

Outcome #3

1. Outcome Measures

of Extension publications

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	2	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
312	External Parasites and Pests of Animals
315	Animal Welfare/Well-Being and Protection

Outcome #4

1. Outcome Measures

% producers adopting NMSU recommendations to protect plants and animals

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	50	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
312	External Parasites and Pests of Animals
315	Animal Welfare/Well-Being and Protection

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Government Regulations
- Competing Public priorities

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies and Data Collection)

1. Evaluation Studies Planned

- During (during program)
- Time series (multiple points before and after program)
- Case Study
- Comparisons between different groups of individuals or program participants experiencing different levels of progra intensity.
- Comparison between locales where the program operates and sites without program intervention

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}