Morning Session
(0830 - 1200 h)

1.0 Welcome and Introductions
Chair: Scott Hartley Secretary: Lori-Ann Kaminski
Chairperson Scott Hartley welcomed members and opened the meeting at 8:30 AM. Forty-one
members present (Appendix E) introduced themselves.

2.0 Additions to Agenda – Other Agencies Reports, delete 8.2 Crop Protection Institute, add 8.4
Saskatchewan Aerial Applicators Association

3.0 Approval of 1999 Minutes
Motion: Philip/Olffert. That the minutes of the 39th Annual Meeting of the WCCP be approved.
CARRIED.

4.0 Business Arising from 1999 Minutes
4.1 Subcommittee chairs update sections for posting on web site
Action: Secretary to contact subcommittee chairs with a reminder to forward updates to Dan
Johnson. The Guide has not yet been posted to the web.
Motion: Dosdall/Wise. That the WCCP guide be posted to the Alberta Agriculture, Food and Rural
CARRIED.
4.2 Archiving WCCP minutes?
Action: Secretary to contact Rick Butts regarding availability and progress of an archive of WCCP
minutes.
4.3 Uses of funds from guide sales for future meetings?
Motion: Philip/Olffert. To use the funds from guide sales to sponsor future meetings; in particular to
sponsor special speakers for future meetings.
CARRIED.

5.0 Appointment of WCCP Resolutions Committee
Hugh Philip and Owen Olfert were appointed as members of the Resolutions Committee.

6.0 Provincial Pest Problem Updates – Summaries for 2000 (Appendix A)
6.1 British Columbia – Hugh Philip
6.2 Manitoba – John Gavloski
6.3 Alberta – Jim Jones, presented by Lloyd Dosdall
6.4 Saskatchewan – Scott Hartley
6.5 Appoint Provincial Pest Problem Summarizers

**Motion:** Chair. That Provincial pest problem summarizers will remain the same for 2001.
CARRIED.

**Coffee**

### 7.0 Research Report Updates – Summaries for 2000 (Appendix B)
- 7.1 British Columbia – Bob Vernon
- 7.2 Alberta – Jennifer Otani
- 7.3 Saskatchewan – Martin Erlandson
- 7.4 Manitoba – Ian Wise
- 7.5 Appoint summarizers

**Motion:** Chair. That Research Report Summarizers remain the same for 2001 or appoint their replacements. CARRIED.

**Lunch**
(1200 - 1300 h)

**Afternoon Session**
(1300 - 1800 h)

### 8.0 Other Agency Reports (Appendix C)
- 8.1 Pest Management Regulatory Agency - Ground squirrel issues – Najib Rashid
- 8.2 Canadian Food Inspection Agency – Brian Rex
- 8.3 Saskatchewan Aerial Applicators Association – Lorin Rubbert

**Coffee**

### 9.0 Review of WCCP Guide and Subcommittee Chairs

Chapter Authors for 2001 are:
- Cereal Crops and Grain Corn – Olfert/Johnson
- Oilseed Crops – Wise/Dosdall
- Forage Crops – Soroka
- Special Crops – Jones
- Household Pests – Broatch/Byers
- Home Vegetable Crops – Broatch/Byers
- Commercial Vegetable Crops – Vernon
- Greenhouse Crops – Costello
- Interior Plantscapes and House Plants – Calpas
- Mushrooms – Vernon
- Berry Crops – Vernon
- Tree Fruits – Philip
- Shelterbelts, Ornamental Trees and Shrubs – Neill
- Seasoned Wood and Timber Structures – Philip
- Turf – Dolinski
- Warehouses and Farm Stored Grain – White
- Hazards and Safeguards in Applying Insecticides to Crops in Bloom - Soroka
10.0 New Business - Issues and Concerns – no new business other than that covered under 4.0 Business arising from 1999 minutes.

11.0 Special Reports (Appendix D)
   11.1 Entomological issues involving the biological control of noxious weeds – Garry Bowes (Coordinator, Noxious Weeds Management Program)
   11.2 Insect pest issues in North Dakota – Janet Knodel (NDSU Extension Service)
   11.3 Montana update of entomology programs – Tom Shanower (USDA, Montana)
   11.4 Glassy cutworm update in Alberta – Lloyd Dosdall (AARD, Edmonton)
   11.5 Ecological risk assessment of transgenic crops / insect resistance – Lorraine Braun (AAFC, Saskatoon)

12.0 Election of 2000/2001 WCCP Executive – by acclamation
Chair Lloyd Dosdall Secretary as appointed by Lloyd Dosdall
ECIPM representative Hugh Philip
Meeting 2001 to be held in October at the next Western Forum, an Alberta location chosen by the executive.

13.0 Resolutions – Philip/Olfert report no resolutions.

14.0 Unfinished Business – none

15.0 Adjournment – 1730
Motion: Olfert/Bulman. Adjourn no evening session required.
CARRIED.

APPENDIX A: 2000 PROVINCIAL INSECT PEST REPORTS 4
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Summary

Alfalfa weevil outbreaks were reported from several areas in the southern Interior. Grasshopper abundance was noticeably greater in the BC Peace River region, East Kootenay and in the Thompson and Nichola valleys of the southern Interior. An alert was sent out to ranchers and farmers to note hopper abundance and distribution this fall. Cutworms (glassy, yellowheaded, others) appeared in large numbers in grass and a few canola crops in the Peace River region, resulting in moderate damage to some fescue and timothy seed crops. Lygus bugs were present in moderate to high numbers in canola crops. Good summer growing conditions helped the plants compensate for moderate early season feeding injury. Cereal leaf beetle has yet to reach economic levels in wheat crops in the Creston Valley, however some spring wheat growers continue to spray for wheat midge. A midge parasitoid introduced in the early 1990’s from the Okanagan Valley has become established in the Creston Valley. Control of the potato psyllid is causing problems for greenhouse pepper and tomato operations vis-à-vis disruption of biological control programs.

Cereal Crops

Cereal leaf beetle (*Oulema melanopus*): Populations continue to remain below economic levels. Parasitoid releases (parasitized beetles from Idaho) will not be released until populations increase to levels that will ensure establishment of the parasitoid. Assuring California authorities that sweet corn shipments from the Fraser Valley are free of CLB has averted an embargo on the produce for now.

*Euxestonotus error*, a parasite of wheat midge, was found in spring wheat crops in the Creston Valley for the second straight year confirming its establishment. Unfortunately Macroglenes penetrans, a midge parasite collected from Saskatchewan and released on three separate occasions in the Creston Valley, has yet to be recovered. Spring wheat growers must continue to monitor for wheat midge each year and take corrective action until the parasitoid population can keep the pest below action levels.

Grasshoppers (mainly *Melanoplus sanguinipes, Camnula pellucida*): severe infestations (>80/sq m) were investigated in the Hudson Hope area of the BC Peace River region. Total stripping of leaves was evident and the risk of head clipping increased as the crops were maturing.

Oilseed Crops
**Cabbage seedpod weevil** (*Ceutorhynchus assimilis*): high adult populations in some canola crops in the Creston Valley required insecticidal control. Samples of adult weevils were sent to Dr. Owen Olfert (AA-FC, Saskatoon) to rear out and identify any parasitoids present. A canola crop near Enderby was written off by crop insurance due to the pest. The owner has grown canola in the area for a number of years and had never noticed CSPW or its damage. Wild mustard and possibly other wild host plants are present in the area. Its presence was suspected in experimental plots grown near Armstrong by the BCMAFF several years ago. The following tables present the results an examination of pod samples collected while the crop was still standing and very mature (two samples of 100 and 108 pods labeled west and east end respectively).

**Table 1.** Number (and %) of seedpods from which CSPW larvae emerged.

<table>
<thead>
<tr>
<th>Sample site</th>
<th>Total pods collected</th>
<th>Number non-infested pods</th>
<th>Number infested pods</th>
</tr>
</thead>
<tbody>
<tr>
<td>West end</td>
<td>100</td>
<td>24 (24)</td>
<td>76 (76)</td>
</tr>
<tr>
<td>East end</td>
<td>108</td>
<td>12 (11)</td>
<td>96 (89)</td>
</tr>
<tr>
<td>Totals</td>
<td>208</td>
<td>36 (17)</td>
<td>178 (83)</td>
</tr>
</tbody>
</table>

**Table 2.** Comparison of the number of intact seeds/pod from pods with varying number (0 - 3+) of exit holes (non-infested pods = 0 holes).

<table>
<thead>
<tr>
<th>Sample site</th>
<th>0 holes</th>
<th>1 hole</th>
<th>2 holes</th>
<th>3+ holes</th>
</tr>
</thead>
<tbody>
<tr>
<td>West end</td>
<td>22.8</td>
<td>16.8</td>
<td>11.5</td>
<td>17*</td>
</tr>
<tr>
<td>East end</td>
<td>16.1</td>
<td>13.6</td>
<td>10.4</td>
<td>7.9</td>
</tr>
<tr>
<td>Average</td>
<td>17.8</td>
<td>15.3</td>
<td>10.8</td>
<td>9.0</td>
</tr>
</tbody>
</table>

*One pod only

There were on average 14% fewer intact seeds in pods with one exit hole. However, pods with 2 and 3+ holes had 39% and 49% fewer intact seeds, respectively.

**Table 3.** Number (and %) of infested pods with 1, 2 or 3+ holes/pod from each sample site.

<table>
<thead>
<tr>
<th>Sample site</th>
<th>1 hole</th>
<th>2 holes</th>
<th>3+ holes</th>
</tr>
</thead>
<tbody>
<tr>
<td>West end</td>
<td>56 (73.7)</td>
<td>19 (25)</td>
<td>1 (1.3)</td>
</tr>
<tr>
<td>East end</td>
<td>51 (53.1)</td>
<td>38 (39.6)</td>
<td>7 (7.3)</td>
</tr>
<tr>
<td>Total</td>
<td>107 (62.2)</td>
<td>57 (22.1)</td>
<td>8 (4.7)</td>
</tr>
</tbody>
</table>

Overall, CSPW larval and adult feeding reduced the number of intact seeds per pod by 27%. For the west end sample, there were 30.7% fewer intact seeds per infested pod; for the east end sample, there was 26.1% fewer intact seeds per infested pod. There was no pattern to the location of exit holes. Adult feeding and oviposition holes and scars were quite evident. No larvae were found in the pods.
Lygus bugs (*Lygus spp.*) were present in varying numbers in all 33,000 ha of seeded canola in the BC Peace River region. About 8,000 ha were sprayed with Matador™ at the bud/prebloom stage (usually tank mixed with glyphosate herbicide). Treatment resulted in low lygus populations for the rest of the season. Favorable summer growing conditions allowed the crops to compensate for early season feeding injury.

**FORAGE CROPS**

**Alfalfa weevil (*Hypera postica*)**: is common throughout the southern Interior and early first cut usually prevents economic crop loss and subsequent feeding on regrowth. The past two years have seen an increase in economic populations in the southern Interior to the point that some regrowth was sprayed this summer. In one instance Sevin XLR, applied by ground sprayer following US label rates (product is not registered for such use in Canada), resulted in leaf burning. The injury did not appear to impact recovery and subsequent yield of the crop.

**Alfalfa looper (*Autographa californica*)**: caused widespread yield reductions in forage alfalfa and grass crops in combination with dry, cool conditions in May and June in the East Kootenay region of SE B.C. The feeding injury did not appear to reduce yield of the second-cut crop.

**Grasshoppers** (mainly *Melanoplus sanguinipes*, *Camnula pellucida*): increased abundance and forage losses were reported from the BC Peace River and East Kootenay regions as well as the Thompson and Nichola valleys in the southern Interior. In the East Kootenay, rangelands areas are large enough and varied enough in topography, tree canopy, elevation, etc. that the impact on forage availability to livestock was not significant. Smaller landowners did suffer significant forage reductions where infestations were high. Several complaints were received from acreage and rural residents about damage to their gardens and horse paddocks. In the BC Peace River region, alfalfa regrowth was consumed as it appeared in some harvested crops; unharvested plants were severely defoliated. Delayed response to economic populations resulted in poor efficacy of both liquid and bran-bait control products.

**Glassy cutworm (*Apamea destructor*), yellowheaded cutworm (*Apamea amputatrix*), and unidentified cutworms**: appeared in many grass (timothy, fescue) seed crops and a few canola crops in the BC Peace River region. Moderate damage was inflicted to some grass seed crops, especially where dry fall/spring conditions were experienced. In almost all cases, infested fields recovered to produce satisfactory yields. Fall monitoring of cutworms confirmed their presence in older grass seed fields but high densities were not observed in 1- and 2-year old stands.

**HORTICULTURE CROPS**

**Alfalfa looper (*Autographa californica*)**: some localized infestations in market garden vegetable operations in the south Okanagan.

**Pear slug (*Caliroa cerasi*)**: infestations on pear and cherry in throughout the Okanagan Valley but no impact on fruit quality.

**Potato psyllid (*Paratrioza cockerelli*)** is creating problems in greenhouse pepper and tomato operations in the Fraser Valley. Insecticides are the only options available and some are disrupting biological control programs of other pests.
**Black vine weevil** (*Otiorhynchus sulcatus*): Continues to challenge raspberry growers in Fraser Valley. There is concern over lack of effective, IPM-compatible control products against this common pest.

**Wireworms:** Two economic species of wireworm, the lined click beetle (*Agriotes lineatus*) and the obscure click beetle (*A. obscurus*), were not found during a survey of the Nichola, Thompson, Similkameen and Okanagan valleys using pheromone-baited traps. Surveys in the Fraser Valley revealed they have now reached Chilliwack. These two species continue to be a major threat to potato crops in the Fraser Valley. One producer reported 100% crop loss (unmarketable tubers) in an unprotected crop. Pyrifen™ 15 G (chlorpyrifos) received an emergency registration for the period May 15 - June 15/00 for use in potato crops. There is no alternative chemical available for such use in B.C. (Thimet™ use is prohibited in B.C.). These species were also implicated in damaged cedar tree nursery stock.

**Tuber flea beetle** (*Epitrix tuberis*): potato crop in Delta (south of Vancouver) suffered economic losses. This crop was not under an IPM program.

**Lygus bugs** (*Lygus* spp.): were attracted in high numbers to test plots of industrial hemp in the BC Peace River area. In spite of densities that would be considered economic in canola, no damage to the hemp was apparent.

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**ORNAMENTALS AND SHELTERBELTS**

**Gypsy Moth** (*Lymantria dispar*): The only aerial spray program was conducted over parts of Burnaby and to date appears to have been successful based on preliminary trapping results. Trapping results from other regions were not available for inclusion in this report.

**Hemlock looper** (*Lambdina f. fiscellaria*): infestations reported on hemlock in the Fraser Valley.

**Broad mite** (*Polyphagotarsonemus latus*): localized infestations on ornamentals in the Fraser Valley.

**Leatherjackets** (crane flies): adults very numerous in Fraser valley and southern Interior prompting many calls for control information.

**Bruce spanworm** (*Operophtera bruceata*) and the **large aspen tortrix** (*Choristoneura conflictana*) caused localized defoliation of poplar groves throughout the BC Peace River area.

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**STRUCTURAL & NUISANCE**

**Western Boxelder Bug** (*Boisea rubrolineata*): Numerous calls for control recommendations received in spring and late summer from cottage and home owners in Southern Interior.

**Western Subterranean Termite** (*Reticulitermes hesperus*): the impending loss of chlorpyrifos for protection of buildings from this pest has many termite control operators very concerned. Only cypermethrin (Dragnet™) will be available.

**Hobo Spider** (*Tegenaria agrestis*): media reports on the hobo spider spurred a deluge of inquiries and specimens to BCMAFF offices. The spider has a potent, but non-fatal venom that causes nasty bites. It
is easily confused with two other closely related species present over the same range in southern BC.

**ISSUES**

1. Cherry growers urgently require replacement products for carbaryl, malathion, dimethoate and diazinon to control western cherry fruit fly. Phytotoxicity to new varieties, possible changes in use patterns and availability, lack of satisfactory control, and changes in foreign pesticide regulations requires growers to seek alternative control products. Their competition in the US can use the new active spinosad, which was unexpectedly denied registration in Canada this year.

2. The impending loss of chlorpyrifos for protecting buildings from western subterranean termite will leave cypermethrin as the only termiticide registered in Canada. Several termiticide baits are available in the US that are not harmful to the environment because of their mode of action (growth regulators) and method of application (bait stations). These bait products are wanted and soon to be needed by termite control operators, however the cost of registration and small market work against commercial interest to develop these products in Canada.

3. Fraser Valley potato growers face a major threat from the lined and dusky click beetles because of the lack of suitable chemical control products. There is no guarantee the emergency use permit for Pyrifos™ will be renewed in 2001. There are no alternative non-chemical control options at present. One potential control tactic (R.S. Vernon, PARC, Agassiz) is the use of fipronil applied to cereal seed and sown in single rows between rows of potatoes. The interplanting of cereals has proven effective in reducing wireworm depredation of adjacent potato tubers. Use of seed treatments would greatly reduce amount of active ingredient applied compared to broadcasting granular formulations.

**EXTENSION PROGRAMS**

**Infobasket:** In August 1999 the BCMAFF decided to move towards a more client focused approach to information delivery. This decision was based on the need to respond to changing client expectations of information availability and delivery, and MAFF’s ability to respond accordingly. BCMAFF developed the Information Management Framework, from which evolved the Infobasket service, to improve client and staff access to information. A pilot project involving Ornamentals and Organics is completed; Special Crops is now in progress. Infobasket will be accessed from the BCMAFF web site using the Plumtree portal software that provides personalised viewing of documents selected from the World Wide Web and Ministry file directories.

**Growing With Care:** is the title of a 5-year $2-million project of the BC Fruit Growers’ Association to investigate the production of pome fruit without use of conventional insecticides and fungicides between bloom and harvest, and to reduce pesticide use on soft fruits. Consultations will be held with tree fruit researchers and advisors to identify and prioritize research and demonstration sub-projects directed to achieving the project goal. Marketing opportunities for the potential end product will be investigated at the same time.

**FUTURE PLANS**

Work with the PMRA to get a termiticide bait and cherry fruit fly control products registered in Canada.
Continue to search for *Macroglenes penetrans* in the Creston and Armstrong areas. Participate in grasshopper control information meetings as requested.

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*ALBERTA INSECT PEST REPORT, 2000*

Lloyd M. Dosdall, Ph.D.  
Provincial Entomologist  
Alberta Agriculture, Food and Rural Development  
Edmonton, AB   T6H 5T6

**CEREAL CROPS**

**Grasshoppers**, (primarily *Melanoplus bivittatus* and *Camnula pellucida*). The grasshopper forecast for 2000 predicted severe grasshopper infestations in Alberta, particularly in the northwest, Peace River, and southern regions of Alberta. Cool temperatures in spring appeared to delay the hatch of overwintered eggs, giving crops relatively good compensatory ability. However, significant grasshopper infestations developed in the Peace River region, as well as in southern Alberta and eastcentral regions of the province. A newly registered product, Eco-bran™, comprised of wheat bran impregnated with insecticide, was available for the first time for grasshopper control in pastures. This product could be applied without having to remove beef cattle from pastures, but was found to have poor efficacy in some situations. The most common grasshopper species in outbreak areas was the clear-winged grasshopper (*Camnula pellucida*), and in several sites populations were heavily infested with the pathogen, *Entomophaga grylli*. Mortality from this natural control agent enabled many growers to avoid insecticide applications for grasshopper control.

**Orange Wheat Blossom Midge**, (*Sitodiplosis mosellana*). Severe infestations of orange wheat blossom midge occurred in eastcentral Alberta in 2000. In many fields populations exceeded the economic threshold, and for the first time in our province insecticide applications were needed to control this pest. Approximately 5,000 acres were sprayed in the outbreak zone which included Paradise Valley, Wainwright, and Lloydminster. Crop losses from midge were observed as far west as Vermilion and Vegreville. A comprehensive soil survey was conducted in eastern Alberta late in the season in 2000 to provide predictive information for wheat midge densities in 2001.

**Wheat Stem Sawfly**, (*Cephus cinctus*). Severe infestations of wheat stem sawfly were observed at several sites in southern Alberta, particularly near Lethbridge, Hilda, and Medicine Hat. Crop damage was characterized by many lodged plants and reduced yields. Wheat growers in the region are being encouraged to plant resistant cultivars.

**Cereal Leaf Beetle**, (*Oulema melanopus*). Alberta is surrounded by cereal leaf beetle: it is a serious pest of virtually all cereal crops in Creston Valley, BC, Montana, and in many other US states. It seems certain to disperse here eventually, and it is our hope to discover it early in its invasion phase so it can
be eradicated from Alberta. A survey of approximately 80 fields in southern Alberta near the U.S. border was conducted in 2000, but no adults or larvae of this pest were found.

**Wheat Head Armyworm,** *(Pseudaletia inipuncta).* Wheat head armyworm numbers were much higher in southern Alberta in 2000 than in previous years. Larvae caused substantial damage to cereal crops, particularly wheat and barley, by feeding on developing heads in early August.

**Red-Backed Cutworm,** *(Euxoa ochrogaster).* Crop damage from redbacked cutworm was severe in several fields in the southern Peace River region, and in central Alberta. Although cereals, especially barley, were crops were most severely infested, reports were also received of significant damage to some canola crops.

### OILSEED CROPS

**Cabbage Seedpod Weevil,** *(Ceutorhynchus obstrictus).* Outbreak densities of cabbage seedpod weevil occurred throughout southern Alberta in 2000. Although this pest was only discovered infesting canola in Alberta in 1995, its populations increased 320-fold between 1998 and 2000, and 14-fold between 1999 and 2000. Alberta Agriculture, Food and Rural Development applied for, and received, emergency registration for Decis® (deltamethrin) for weevil control, and approximately 75,000 acres of canola were treated with insecticide to control this pest. The recommended application time was when crops were in 10% flower, using an economic threshold of 3 to 4 adult weevils per sweep net sample. The range of the weevil expanded in 2000 to include southwestern Saskatchewan and central Alberta as far north as Hanna and Oyen. The severe drought that occurred in southern Alberta was detrimental to weevil populations: numbers of new generation adults emerging from canola stubble declined dramatically in 2000, and many dead larvae were found within canola pods.

**Lygus Bugs,** *(Lygus spp.)* Lygus bug numbers in 2000 were substantially lower than those in 1998 and 1999, and relatively few acres were sprayed with insecticide to control their populations. The most severe Lygus infestations occurred in the southern Peace River region. High adult populations (e.g., 3 to 4 per sweep) were reported in bud/bolting canola, and several growers applied insecticide with their second application of herbicide to transgenic crops.

**Flea beetles,** *(Phyllotreta spp.)* Although flea beetle populations were not particularly damaging in spring of 2000 in most sites throughout Alberta, numbers of new generation adults in August were extremely high in southern Alberta and in some sites in central regions of the province. Lindane (Vitavax rs®) will still be available for the 2001 crop year, but thereafter canola growers will need to rely on other newly registered insecticidal seed treatments for flea beetle control.

**Root maggots,** *(Delia spp.)* Root maggot infestations were severe in central Alberta, especially following heavy rains in mid-June. Egg and larval numbers at Lacombe, Vegreville and Ellerslie were very high, resulting in many killed plants and excessive mid-day wilting of leaves.

**Bertha Armyworm,** *(Mamestra configurata).* Based on parasite populations in larvae of bertha armyworm from 1996 to 1999, no significant infestations of this pest were predicted for 2000. Predictions proved accurate, with no reports of crop loss. Provincial pheromone monitoring data found that high adult populations occurred in southern Alberta near Vulcan, but these did not translate to high larval numbers in nearby canola fields.
FORAGE CROPS

Alfalfa Weevil, *Hypera postica*. Severe infestations of alfalfa weevil were reported in alfalfa seed and forage crops in southern Alberta near Brooks, Lethbridge, and Vulcan. In most cases, crop damage was managed by early cutting of alfalfa crops.

SPECIAL CROPS

Glassy Cutworm, *Crymodes destructor*. An outbreak of glassy cutworm occurred in grass seed crops in the Peace River region of Alberta and British Columbia in 2000. Crops most severely infested were two- to four-year-old stands of creeping red fescue, timothy, and tall red fescue; one-year-old stands were not heavily damaged. Damage was first observed in May 2000, and was initially attributed to winter-kill. However, many fescue tufts were found to contain cutworm larvae (as many as 20 to 50 larvae per 50-cm-diameter tuft) in the crown and root zones of plants. Larvae were in varying stages of development ranging from early (larval length = 1 cm) to final instars (larval length = 3 cm). Crop damage consisted of destruction of plant stands to varying degrees ranging from some killed plant tillers within tufts to entire fields completely destroyed by cutworms. Damage tended to be greatest in chaff rows – the regions within fields where plant material had been piled during the preceding year in the swathing process. Approximately 80,000 acres of pasture and cropland were affected to varying degrees by glassy cutworm, resulting in economic losses estimated at 5 million dollars. The region most severely infested by glassy cutworm closely paralleled the area severely affected by drought in 1998 and 1999. In spray trials with insecticides, greatest efficacy was achieved with applications made before or during a rain, which enabled the active ingredient to be transported beneath the surface to the crown region of the plant where cutworm larvae were feeding.

2000 SASKATCHEWAN CROP INSECT REPORT
SUBMITTED TO THE WESTERN COMMITTEE ON CROP PESTS OCTOBER 16, 2000 MOOSE JAW, SASKATCHEWAN

SUMMARY

Overall crop insect pests were not severe for most crops in most areas during the 2000 growing season. Cool, wet conditions did not favour the insects as much as crop diseases. Flea beetle problems were down from the previous two years. Lygus bug infestations in canola, were highest in areas similar to 1999 - in the northwest and northeast. Thrips were an additional concern in the northeast. Bertha armyworm populations remained low in 2000. Diamondback moths were not observed at economic levels. There were reports of high numbers of Cabbage moths in some canola fields in the northwest. The Cabbage Seed Pod weevil crossed into Saskatchewan in May. Grasshopper infestations, although high in some areas, did not warrant control except in the west central region. The lower economic threshold for grasshopper s in lentil combined with the increase in pulse crop acreage in Saskatchewan meant producers monitored closely for infestations, especially in high risk areas. Even the Orange Wheat Blossom Midge did not account for intense and widespread application of insecticide as in previous years in Saskatchewan. There were increased reports of Hessian Fly in the southeast and the Wheat Stem Sawfly has continued its resurgence across southern Saskatchewan. Forage producers in the southeast had serious infestations of the alfalfa weevil in the
spring and in the northeast, the Lesser Clover Leaf Weevil caused losses in red clover seed crops. The Aster leafhopper arrived early in 2000 and was found in a coriander stand near Prince Albert. The Wild Rice worm remains a serious problem for organic production of wild rice in northern Saskatchewan.

**CEREAL INSECTS**

**Orthoptera: Grasshoppers** – The Grasshopper Forecast for Saskatchewan identified a “corridor” running from Saskatoon south and west toward Kindersley and the Alberta border as a high risk area for grasshoppers in 2000. This area, coupled with a region identified by both Saskatchewan and Alberta surveys showed potentially severe infestations straddling the provincial border. This border region is much the same area as identified as high risk for a number of preceding years and extends from north of Maple Creek, to north of Unity. The main areas of pesticide application were in the west central region of the province when environmental conditions favoured grasshopper development. As a result of good returns for pulse crops in 1999, acreages increased tremendously in 2000, especially in chick peas. The Rosetown and Kindersley area, south-west of Saskatoon have significant pulse crop acres and also included the highest risk area for grasshoppers in 2000. The low economic threshold for grasshoppers in lentil has resulted in producer concerns for most pulse crops. The lack of information on insect pests in some of the ‘newer’ crops remains a problem. The 2000 Fall (adult) Survey has been completed.

**Diptera: Orange Wheat Blossom Midge - *Sitodiplosis mosellana* (Gehin)** - The 1999 Fall Wheat Midge Survey suggested a reduction in wheat midge populations for most of Saskatchewan. Although the survey portrays an estimation of the populations that exist going into the next growing season, the disclaimers identify that environmental conditions will be the main factor affecting insect populations the following year. In 2000, the low populations observed from the 1999 survey coupled with environmental conditions that appeared to be unfavourable to the midge, resulted in greatly reduced insecticide application over most of the province. The major exceptions to these generalizations were in the frontier areas. High numbers of cocoons were found in the fall of 1999 all along the western edge of Wheat Midge expansion. Reports in 2000 verified significant infestations in the south central (Assiniboia, Ogema), southwest (Stewart Valley, Cabri), west central (Kyle, Dinsmore) and the northwest (North Battleford, Lloydminster). Reports suggest that the most serious problems related to inexperience with the pest. Common and familiar concerns involved poor timing of control relating to delayed and sustained emergence of the midge over a period of time. Other reports of apparently high populations of wheat midge went unnoticed until the grain was harvested. For the rest of the province insecticide application was reduced and severe infestations more isolated.

New research information published by A.A.F.C. (Saskatoon) has shown that early seeding of Hard Red Spring Wheat and Durum is generally not a viable option for agronomic management of the wheat midge. As a result of the Canadian Grain Commission’s new grading tolerances, a new consideration for an economic threshold for wheat midge was introduced. To maintain optimum wheat grades a producer should use an economic threshold of 1 midge per 8 to 10 wheat heads. The traditional threshold of 1 midge per 4 or 5 wheat heads remains when considering yield alone. This information was relayed to producers through extension agrologists and media releases. The degree-day model for midge development appears to have been accepted as a valid tool in wheat midge management. The degree-day maps as released by the Tri-Provincial monitoring Group are now being expected.
Chlorpyrifos based insecticides were the products of choice for wheat midge control.

A 2000 fall soil survey to estimate midge populations and parasitism is being conducted.

**Other Diptera – Wheat Stem Maggot** – *Meromyza americana* (Fitch) - There were scattered reports of wheat stem maggot from across the province in 2000.

- **Hessian Fly – Mayetiola destructor** (Say) - There were reports of Hessian Fly problems in the southeast region (Moosimin, Carnduff). Hessian fly pupae were identified from samples brought in to the Regina Rural Service Centre.

**Hymenoptera: Wheat Stem Sawfly** – *Cephus cinctus* Norton – Reports in 2000 verify the resurgence of the Wheat Stem Sawfly across southern Saskatchewan and as far north as Saskatoon and AAFC (Scott). The most serious reports are in the Southwest as in 1999. Identification of resistant varieties of hard red spring and durum wheat varieties has become of great interest to affected producers. In many cases damage has been observed across the field, not isolated to field margins. Some of the most serious infestations were in the west, near the Alberta border. Fields with severe cutting were also reported in the Shaunavon and Cabri / Lancer areas. Hard red spring and durum wheat varieties were affected.

**OILSEED INSECTS**

**Coleoptera: Chrysomelidae: Alticinae - Crucifer Flea Beetle** – *Phyllotreta cruciferae* (Goeze)

Significant infestations of flea beetles were reduced and widespread compared to 1998 and 1999. Most producers use seed treatments and little or no foliar insecticides were applied in 2000. Lindane based treatments were still available in 2000 and although there is some concern over newer, higher priced treatments for flea beetle control. However, if heavy infestations are expected, based on previous fall numbers, producers often turn to more expensive treatments for extended control.

**Curculionidae: Ceutorhynchinae - Cabbage Seed Pod Weevil** – *Ceutorhyncus assimilis*

Saskatchewan surveys in late May and early June, along the Alberta border, detected the presence of the cabbage seed pod weevil. A.A.F.C. and Saskatchewan Agriculture and Food found weevils in wild crucifer stands (e.g. flaxweed, wild mustard) and canola from the Maple Creek area, north toward the South Saskatchewan River. Eastward migration was observed approximately 50 kilometres into the province, less than 16 kilometres east of Maple Creek. This area is isolated from the majority of the canola-growing region in Saskatchewan by the Great Sand Hills to the east and a relatively large non-traditional canola growing area to the north. However this is a significant migration eastward and there is more canola and mustard grown in the region than in previous years. Alberta Agriculture and Rural Development and ECORC (Ottawa) made positive identification of the weevils.

**Thysanoptera: Thrips** – In the northeast (White Fox, Choiceland), A.A.F.C. (Saskatoon) surveyed a number of fields observing significant densities of thrips. Populations in 1999 resulted in flower loss and/or deformed pods. Populations in 2000 were reduced overall but the existence of Lygus bugs in conjunction with thrips in this area, may represent the necessity for a joint economic threshold. The AAFC survey estimated damage to over 40% of the pods at one location where high densities of both Lygus and thrips were present.
Lepidoptera: Noctuidae - Hadeninae - Bertha Armyworm - Mamestra configurata Walker -
A pheromone “trapline” was set up by cooperators in 2000 to collect male Bertha armyworm moths. The number of cooperators remained similar to previous years. Interest in keeping the number of traps nearer 200 was keen even though the population is on the low end of a cycle. Two locations above 600 accumulative moths were identified in the northeast, near Nipawin and in the southwest, near Herbert. Follow-up monitoring did not reveal significant numbers of larvae. The Herbert site appeared questionable but it is an experienced cooperator and the trap was somewhat unique for the area, being on an irrigated field. No insecticides were applied for Bertha armyworm in 2000.

Plutellidae - Diamondback Moth - Plutella xylostella (Linnaeus) - Monitoring for DBM continued again in 2000 with a number of sentinel traps and sweep sampling. No significant infestations were reported.

Hemiptera: Miridae - Lygus - Lygus spp. – A Lygus survey in canola was conducted in 2000 that included population densities and species collection. The highest densities were in Meadow Lake (NW) and Choiceland (NE) as in 1999. The data was mapped and posted on the SAF website. Identification of any dominant species is the goal of the species collection.

PULSE AND SPECIALTY CROP INSECTS

Orthoptera: Grasshoppers - The 2000 Grasshopper Forecast map (based on 1999 Fall observations) showed the area south and west of Saskatoon towards Kindersley and the Alberta border to be the highest risk for grasshopper infestations. Lentil and chick peas were affected by grasshoppers in many areas later in the season. The economic threshold has been established for lentil. Field peas are considered to be more resistant to grasshopper feeding. However other crops such as chick pea are a concern since no economic thresholds are established because it is a relatively new crop in Saskatchewan. However chick pea acreage is rapidly expanding.

Homoptera: Cicadellidae – Six-spotted or Aster Yellow leafhoppers were identified in coriander early in 2000. Flight trajectories, from Environment Canada, did not provide evidence of favourable winds from the south and therefore there has been speculation that the adults could be capable of over-wintering in Saskatchewan. The 1999 – 2000 winter was the fourth mildest on record. Aster Yellows were also evident in Echinacea.

Aphididae - Aphids - Aphids exceeded economic thresholds in canaryseed in August. Problems were not as widespread as in 1998 and 1999. Dimethoate and malathion products were most commonly used for control.

Lepidoptera: Noctuidae - Rice Worm - Apamea apamiformis [Guenee] - Wild rice in northern Saskatchewan has been experiencing severe infestations of wild rice worm. Originally the most severely affected areas were near the Saskatchewan/Manitoba border (east) and in the Meadow Lake area (west). Now the problem appears to be more widespread with infestations affecting the conditioning plants themselves. There has been some suggestion that transporting infested rice from outlying areas to the central conditioning plants in La Ronge has increased the spread of the rice worm. There are limited chemicals registered for use but research from the U.S. suggests that insecticides can be quite effective. However this is of no value to the higher value organic product and producers
are looking for acceptable, reliable biological controls. Bacillus thuringiensis (var. kurstaki) has not proven to be effective in American trials.

**Forage Crops**

**Coleoptera: Curculionidae – Hyperinae - Alfalfa weevil – Hypera postica (Gyllenhal)** – Alfalfa weevils were reported as a significant pest in alfalfa and clover in the southeast part of the province.

**Lesser clover leaf weevil – Hypera nigrirostris** (Fabricius) – The Lesser clover leaf weevil was a pest in some red clover fields in the Tisdale area, resulting in an estimated seed yield loss of greater than 50%.

**Stored Grain Insects**

There have been some inquiries by foreign customers regarding various insects in various stored agricultural products (e.g. mustard, canola and alfalfa dehydration) and possible control measures applied in Saskatchewan.

**Vegetable Crop Insects**

**Aphids and Colorado Potato Beetles** were the major insects affecting vegetable crops in Saskatchewan in 2000. The Green Peach aphid – *Myzus persicae* (Sulzer) was reported in potatoe crops and was monitored as a potential disease vector.

**Other**

**Lepidoptera: cabbageworms - Pieris rapae** (Linnaeus) in cole crops.

**Homoptera: Woolly elm aphids, Eriosoma americanurn** (Riley) on saskatoon shrubs.

**Major Insect Pest Issues for Saskatchewan**

The existence of the Tri-Provincial Monitoring Group has had a very positive impact on dealing with crop pests. The availability of information from degree-day models for predicting development and emergence of crop pests has offered a fairly reliable tool for extension personnel and producers. The tri-provincial aspect is especially helpful for Saskatchewan’s border regions where information from Alberta and Manitoba locations is often more relevant to their situation.

Cabbage seed pod weevil in Saskatchewan

Wheat midge management, especially in frontier areas

Concerns and misconceptions regarding insecticides - e.g. Loss of Dursban - being replaced with Methoxychlor (as a “less hazardous” insecticide) for control for bark beetles / Dutch Elm disease

Mosquito control - West Nile Virus

Flea beetle control in the absence of the more inexpensive lindane based seed treatments.
Similar to the lindane issue, the future of insect control in the wake of the FQPA

Establishing economic thresholds - especially for “new” pests and in “new-” crops but also fine tuning existing economic thresholds

Insects as disease vectors - e.g. Aster Yellows and leafhoppers

**FUTURE PLANS**

1) Highlighting IPM - Saskatchewan Agriculture and Food has identified Integrated Pest Management as a priority area.

2) Continuing monitoring and survey programs

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**SASKATCHEWAN FRUIT PEST SURVEY 2000**
*C. C. Peters, Saskatchewan Agriculture and Food*  
*October 10, 2000*

The survey for pest and diseases on native and cultivated fruits in Saskatchewan was reduced somewhat from previous years, because of travel restraints

**Saskatoon**
Common pests of saskatoons, such as saskatoon bud moth, woolly elm aphids, saskatoon sawflies, and apple curculio, and McDaniel mite, while present, were less of a problem in 2000, than average. There are several new developments, however, since the last survey report based on saskatoon insect surveys conducted in 2000.

**Apple maggot, *Rhagoletis pomonella* (Walsh)**
The apple maggot is believed to be native to eastern North America. Hawthorn is usually cited as being the natural native host. I first discovered apple maggots in Saskatchewan in 1979 in crabapples from Assiniboia, and since then it has been reported from many urban centres throughout the province. In 1993, I reported first observing the apple maggot (fruit fly) ovipositing on saskatoon fruits in my own orchard and I subsequently reared one maggot to maturity through the winter. The question at that time was whether or not saskatoons were or would become an alternate host for the maggot, since it has not been reported as a host in the literature that I am aware. In 1999 and 2000, I began surveying for...
Apple maggots on native saskatoons near urban centres where apple maggot had been reported from apples and crabapples in the last five years or so. This year, I captured for the first time, what I believe to be apple maggot flies from native saskatoon stands from a number of these sites. Positive identification is still pending, however, there are no other fruit flies native to this area, that closely resemble the apple maggot fly, with the exact same wing pattern. The blueberry maggot, now recognised as a separate species, *Rhagoletis mendax* Curran, does not occur here, nor does a maggot similar to apple maggot from the west coast, which is reported from snowberry.

Apple maggot fruit flies were found in native saskatoon stands at Assiniboia, Avonlea, Mortlach, Craven, Lumsden, Wascana Creek near Regina, Bulyea and Duval. None were found at sites near Saskatoon and North Battleford to date, however they are common on apples and crabapples within those cities. Fortunately, since oviposition in Saskatchewan usually does not begin until mid July and most commercial saskatoons are harvested before the end of July, problems with apple maggot in saskatoons should be minimal, except for extended storage of fresh product. For those wishing to grow apples commercially or otherwise, the spread of apple maggot in native hawthorn and saskatoons is definitely bad news.

**A Green Slug Sawfly**

There are numerous leaf-feeding sawflies that feed on saskatoons, most often present in relatively low populations. This year a green slug-like sawfly, probably *Fallicampus albostigmus* (Rohwer), which is often captured in surveys in very low numbers, completely defoliated a commercial saskatoon plantation near Bethune in mid to late July. The species is still uncertain, and it is very difficult to rear. However, I currently have a few rearing which are in puparia.

**Hawthorn Lacebug, Corythuca cydoniae (Fitch)**

Native crops and some commercial saskatoon crops near native saskatoon and chokecherry stands suffered considerable damage from attacks by hawthorn lacebugs this year. In some stands the leaves were severely stippled and damaged to the point where leaves were aborted in mid summer, and apical buds broke dormancy to produce new shoots and blossoms in late August. The wintering adult and early spring stages of lacebugs in commercial orchards would normally be controlled by the three allowable applications of Decis, however, there are currently no products registered specifically for the control of lacebugs. Much of the damage by lacebugs is done during fruit ripening stages and post harvest when the plants are establishing new fruit buds for the following year. Lacebugs, as far as I am concerned, should be considered a potential economic pest on saskatoons and chokecherry. The Hawthorn Lacebug, *Corythucha cydoniae* (Fitch), is the only species present on saskatoons.

**Woolly apple Aphid, Eriosoma lanigerum Hausn.**

Some of the damage to the roots of saskatoons previously attributed only to woolly elm aphids, *Eriosoma americana* (Riley) is actually caused by a closely related species, the woolly apple aphid. Their life cycles are similar enough that the treatment for woolly elm aphids is probably also effective against woolly apple aphids. Woolly elm aphids, in our experience in Saskatchewan at least, are more attracted to Northline and Smoky in fields with all cultivars present, however, they will attack all cultivars to some extent. Woolly apple aphids, on the other hand, were found almost exclusively on Marten and Thiessen, in commercial fields, however it is present in numerous wild clones. I have very few reports of infestations from Honeywood. The woolly elm aphid attacks the smaller roots and new suckers of saskatoons, often completely destroying the root systems on young plants. Occasionally as in 1998,
the attack is severe enough to kill plants that are 4 or 5 years old. Woolly apple aphids on the other hand, initially colonize the lower portion of the main shoots, causing them to grow laterally or curve back to the ground. They quickly move to the roots, however, where they cause severe root nodulation and gall formation on the main roots and rhizomes. The damage to the plant is less severe but they are also capable of killing young plants and severely distorting the growth of older plants. Some entomologists consider this species a subspecies of the woolly apple aphid form which is capable of surviving on apple roots indefinitely, while others consider this a separate or new species. In my surveys, until 2000, I had not found woolly apple aphids that remained on saskatoon roots, but rather, returned to elms in fall where they survive the winter in the egg stage. This year, a very active colony of woolly apple aphid was taken from the roots of Thiessen saskatoon at Moosomin on October 12, 2000, all in the wingless stage, with apparently no intention of flying back to the elms.

**Chokecherry and Pin cherry**

Because of reduced interest in chokecherry and pin cherry, currently, for commercial production, I limited my survey for insects and diseases of these crops, to several casual stops.

**Lacebugs**

Several lacebug species are common on chokecherry. The hawthorn lacebug, *Corythuca cydoniae* (Fitch) appears to be the most abundant and damaging. Another species is not certain, but may be *Corythucha pruni* (Osborne & Drake), and a third species which occurs only on a limited number of clones, resembles the willow lacebug, *Corythucha mollcula*, (Osborne & Drake). Lacebugs should also be checked for possible transmission of X-disease on chokecherry, since similar symptoms appeared wherever lacebugs were severe.

**Strawberry**

Reduced vigour and winter injury were the most common problems in strawberry fields in Saskatchewan in 2000 in spite of what was one of our mildest winters on record. At least part of the problems were undoubtedly from loss of snow cover in March, and subsequent cold snaps, however, I strongly suspect that some of the injury was due to Strawberry Crown (Cyclamen) Mites, and we may also be importing nematode problems with imported crowns. I have previously reported on numerous insect and mite species from strawberry fields in the province, that are most likely imported, including the strawberry crown mite, strawberry spider mites, and a number of leaf roller species. In 2000, most of these species were present again, but in lesser numbers.

**Leafrollers**

The obsolete leafroller, *Choristeneura obsoletana* Walker, or *Choristeneura parallela* Robinson (ID uncertain), the strawberry leafroller, *Ancylis comptana* (Froehlich), the variegated leafroller, *Platynota flavedana* Clemens and the omnivorous leafier, *Cnephasia longana* Haworth, all appeared again in strawberry fields to some extent in 2000. The blueberry leafroller, *Sparganothis sulfureana* Clemens, which is fairly common here, was also present. The strawberry garden tortrix, *Ptycholoma peritana*, and the strawberry tortrix, *Acleris comariana* (Zeller) appeared in relatively high numbers in several fields in the southwestern part of the province.

**Raspberry**

Several pests that caused economic losses in 1999 were noticeably absent in 2000. The Raspberry sawfly, which completely destroyed a raspberry crop in the west central region in 1999, was not a problem in 2000, and raspberry fruit worms were much less severe.
True Armyworm (*Pseudaletia unipuncta*): True armyworms were in above threshold numbers in many wheat, barley, oats, and timothy fields in the eastern and interlake parts of Manitoba. Some armyworm problems were reported in other parts of the province as well, but the worst infestations were in the east and interlake areas. Populations exceeding 50 per square meter were reported in some fields. High numbers of adult armyworm moths were noted around Winnipeg early in the year, and there was a lot of lodged crops this year, creating ideal conditions for armyworms. In many fields, populations were well above threshold in the lodged areas of the field, and below threshold in areas of the field that were not lodged. Some farmers were caught in the position where the armyworm populations were above economic threshold levels, but there was also enough fusarium in the field to create uncertainty over whether the barley could be used for its intended purpose (hog feed). This created situations where control decisions were hard to make.

Wheat Midge (*Sitodiplosis mosellana*): Wheat midge numbers were lower this year than in previous years, with very few fields having adult counts at economic levels. The only spraying for wheat midge in Manitoba that I am aware of is a few farms in the southwest close to the Saskatchewan border.

**INSECTS ON CANOLA**

Flea Beetles (*Phyllotreta spp.*): Flea beetle populations were high in canola fields in various locations throughout the province. Because of the low prices for canola, growers were trying to cut input costs and many went without using a granular insecticide or insecticide treated seed. Some of these farmers that
later had high flea beetle pressure applied foliar sprays to control flea beetles, some getting good control by spraying the borders only.

**Bertha armyworm** (*Mamestra configurata*) and **Diamondback moth** (*Plutella xylostella*): Populations of both bertha armyworms and diamondback moth were low and below economic thresholds in canola throughout the province this year. There were some fields of canola and flax in the Hamiota and Shoal Lake areas where bertha armyworm larvae were noticeable late in the season, but still below economic threshold.

**INSECTS ON SUNFLOWERS**

**Sunflower beetles** (*Zygogramma exclamationis*): Sunflower beetle numbers were high and the majority of sunflower growers applied insecticides for control of sunflower beetles. Pyrethroids were used by most farmers for sunflower beetle control.

**Banded Sunflower Moth** (*Cochylis hospes*): Banded sunflower moth larvae became very noticeable in many sunflower fields in August, and some reduced grading of samples is once again anticipated. Growers and processors seem uninformed about banded sunflower moth and some processors end up confusing banded sunflower moth damage to the seeds for sunflower seed weevil damage. This happened last season as well, and sunflower growers in regions that had banded sunflower moth, and no detectable sunflower seed weevil populations in their fields, were being told they had seed weevil damage and should scout for and control seed weevils this year. Sunflower growers seem to not be fully familiar with what red sunflower seed weevil looks like, as many were confusing other things in the field for sunflower seed weevils. One field in particular was sprayed for “sunflower seed weevil” after the minute pirate bug nymphs in the field exceeded the sunflower seed weevil threshold.

**Lygus bugs** (*Lygus* spp.): Lygus bug numbers were very high in flowering sunflower fields. Most of the lygus bugs are in the head, often around the disk petals and developing seeds. It is not known what, if any, damage they are doing there, but the high numbers have a number of sunflower growers concerned. Some think that lygus bugs may be causing a brown spotting that sometimes appears on the seeds, although no studies have been done to confirm that they cause this type of damage in sunflowers.

**INSECTS ON PULSE CROPS**

**Lygus bugs** (*Lygus* spp.): Insecticides were used to control lygus bugs in many of the fababean fields this year. Growers are being encouraged by processors to spray when even low numbers of lygus bugs are found in fababees, since there is a low tolerance for perforated damage on fababees. *Any* more than 1% perforated damage on fababees reduces the quality to Canada #2 beans. Work on economic thresholds for lygus bugs in fababees is needed.

**INSECTS ON VEGETABLES**

**Brassicas**

**Imported cabbageworm** (*Pieris rapae*): There was a late season increase in population, but minimal control was required. Both diamondback moth (*Plutella xylostella*) and cabbage looper (*Trichoplusia ni*) were virtually absent with no efforts made at control all season.
**Cabbage maggot** (*Delia radicum*) numbers were generally low in comparison to other years, although cabbage maggot required fairly persistent control measures through the season on root crops. Growers would very much like to have alternatives to pesticides (or at least reduce dependence) for *Delia* control on rutabaga, Daikon, turnip.

**Onions**

**Onion maggot** (*Delia antiqua*): Sticky trap monitoring indicated that only one generation of adults were observed and/or that the second generation was so small as to be negligible. Growers seem to have little faith in monitoring programs and continued spraying regardless of indicated need. A similar situation was observed with thrip (*Thrips tabaci*) control. Regular field scouting indicated minimal thrip populations combined with unsuitable weather conditions, yet some growers continued to spray.

**Carrots**

**Aster Leafhopper** (*Macrosteles quadrilineatus*): Aster leafhopper numbers were low initially. Infectivity was estimated at 5%, since the University of Wisconsin was unable to provide a measurement. The estimate of infectivity level, while high, is not beyond the range of possibility and the estimate was low the previous year, with high levels of aster yellows in carrots. As of June 1st, only one leafhopper was collected.

The range of values for Aster Yellow Index through the remainder of the season is as follows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Value Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 30</td>
<td>30-135</td>
</tr>
<tr>
<td>July 7</td>
<td>0-45</td>
</tr>
<tr>
<td>July 14</td>
<td>55-135</td>
</tr>
<tr>
<td>July 21</td>
<td>10-160</td>
</tr>
<tr>
<td>July 28</td>
<td>10-115</td>
</tr>
<tr>
<td>August 4</td>
<td>30-435</td>
</tr>
<tr>
<td>August 11</td>
<td>15-825</td>
</tr>
<tr>
<td>August 18</td>
<td>15-210</td>
</tr>
<tr>
<td>September 1</td>
<td>260-5580</td>
</tr>
<tr>
<td>September 15</td>
<td>920-2960</td>
</tr>
</tbody>
</table>

The threshold for carrots ranges from 40 (susceptible) to 100 for resistant varieties. Clearly, we spent a considerable portion of the season well above the economic threshold.

**Potatoes**

**Green Peach Aphid** (*Myzus persicae*); **Potato Aphid** (*Macrosiphum euphorbiae*); **Buckthorn Aphid** (*Aphis nasturtii*); and **Foxglove Aphid** (*Aulacorthum solani*): Aphid numbers were considerably lower than the previous season and it is expected that potato leafroll virus levels will be considerably lower as well.

**Colorado Potato Beetle** (*Leptinotarsa decemlineata*): In spite of a cool, wet spring, Colorado potato beetles in many areas attempted a second generation. Egg laying was occurring well into August with new larvae being regularly observed. In addition, potatoes went in the ground quite early. Beetles emerged late and seed applied insecticide treatments had already begun breaking down, in some cases requiring foliar treatment with insecticides.

**Corn**
**European Corn Borer** (*Ostrinia nubilalis*): Pheromone trapping for European corn borer indicated little activity, as detected by the traps. However, fall scouting has indicated that substantial infestations, in terms of number of stalks infested, number of larvae per stalk and degree of tunneling was surprisingly high. Some fields had 90% of stalks infested, more than half of which had 2 or more larvae per stalk, with extensive tunneling. Surprisingly little stalk breakage has occurred and there seems to have been little cob feeding. Most growers have indicated satisfaction with yields and harvest. I almost hate to tell them about the infestation levels.

Sweet corn growers had a tough year. In addition to ECB numbers, considerable populations of **corn earworm** (*Helicoverpa zea*) were observed (although numbers were minimal in grain and forage corn), as were high numbers of **corn leaf aphid** (*Rhopalasiphus maidis*). Potential for reduction in insecticide use in this area seems minimal. Bt sweet corn varieties would prove very beneficial in reducing environmental impact.

**GENERAL INSECT PROBLEMS**

**Wireworms:** Wireworms were a concern not only in some of their traditional hosts, such as cereals, but also in crops that are not usually damaged significantly, such as sunflowers. Several sunflower fields reported very noticeable wireworm damage, and at least one of these had to be re-seeded.

**Seedcorn Maggot** (*Delia platura*): Some bean and CanaMaize corn fields had high levels of seedcorn maggot, causing concern to growers.

**ISSUES**

**Cereal Leaf Beetle** (*Oulema melanopus*): Cereal leaf beetle moved into North Dakota this past season in 2 of the west-central counties. This insect has never before been found in Manitoba, and being so close a monitoring program was conducted through Manitoba Agriculture and Food and the Canadian Food Inspection Agency. Wheat fields close to Manitoba’s southern border were monitored for cereal leaf beetle. No cereal leaf beetles were found in the Manitoba survey.

**Lygus bugs** (*Lygus* spp.) in buckwheat are a considerable concern. There are no products registered for control and no thresholds have been established. Combine with the observation that a high proportion of flowers naturally abort and we have what may be a significant problem or an imaginary one. Certainly, Lygus is abundant in the crop, largely due to its continuing presence in the field after alfalfa and canola have been harvested. The large populations are likely due to high levels of immigration into the crop. First and second instar nymphs have been observed in the crop, indicating that oviposition and development may occur in the crop.

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1. Title: Evaluation of Bifenazate for Control of Mites on Apple

Author and Associates: Hugh Philip and Lynn Lashuk

Problem: Although European red mite, McDaniel and twospotted spider mites, and apple rust mites are adequately controlled by the western predatory mite (*Typhlodromus occidentalis*), effective miticides are occasionally required to prevent crop injury when the predatory mites are reduced to levels that fail to keep phytophagous mites below action thresholds. Because mites have a history of developing pesticide resistance, it is important that growers have available miticides with alternative chemistries to use in resistance management programs.

Objective of Research: To assess the efficacy of two rates of bifenazate for the control of European red mite and McDaniel spider mite, and to assess its impact on the western predatory mite.

Summary of Results: There was no significant difference in the efficacy of the bifenazate treatments compared to the standard miticide treatment dicofol or to the untreated check. Neither bifenazate treatment had a deleterious impact on the western predatory mite.

Continuing Research: None planned to date.

2. Title: Evaluation of Bioprotec™, a liquid formulation of *Bacillus thuringiensis* var. *kurstaki*, for control of leafrollers on apple.

Author and Associates: Hugh Philip and Lynn Lashuk

Problem: Leafrollers are a major problem in many pome fruit orchards. Many growers are reporting greater dissatisfaction with the performance of OP control products, and other growers are attempting to minimize use of OP products as a result of sub-economic populations of codling moth.

Objective of Research: To evaluate a new formulation of *Bacillus thuringiensis* var. *kurstaki* (Bioprotec) for control of leafrollers on apple.

Results to Date: Bioprotec provided the same level of larval population reduction and fruit protection as the standard Dipel 2X.
Continuing Research: URMULE applications may be submitted for use on other crops depending on the use patterns approved on the first label.

3. Title: Comparative Cost and Performance of Three Codling Moth Management Programs

Author and Associates: Gary Judd and Joy Machuga (Pacific Agri-Food Research Centre), Lynn Lashuk and Hugh Philip, BCMAF, and Howard Thistlewood, Codling Moth Sterile Insect Release Program.

Problem: Members of the BC Fruit Growers’ Association are concerned that the cost of delivering the codling moth sterile insect release program is too expensive compared to alternative control tactics. Comparative cost information is needed so the members can decide on continuation of support for the program which will focus on area-wide suppression in the short-term, eradication over the long term.

Objective of Research: To determine the costs of controlling codling moth using only sterile insect technique (SIT), mating disruption only (Isomate-C® Plus), SIT plus Isomate-C® Plus or conventional chemical control program.

Results to Date: Final results are not yet available. Results from the first year revealed that the SIR and mating disruption blocks had less codling moth damage and fewer codling moth larvae at the end of the season than the conventionally-managed block.

Continuing Research: This is the last year of a 2-year field project.

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Agriculture and Agri-Food Canada, PARC, Summerland: 2000 Insect Pest Research Report

Title 1: Development of a GIS approach to enhance the operational efficacy of the SIR program in the Okanagan Valley of B.C.

Author and Associates: Scott Smith and Grace Frank (Pacific Agri-Food Research Centre, Summerland), Bob Vernon and Todd Kabaluk (Pacific Agri-Food Research Centre, Agassiz), Dan Johnson (Lethbridge Research Centre) and Howard Thistlewood (Codling Moth Sterile Insect Release Program).

Problem: In 1999, the sterile insect release program (SIR) increased the number of Codling moth pheromone traps from 700 to about 3000 in SIR zone 1 orchards in the south Okanagan Valley of B.C. Traps are examined for wild or sterile moths on a weekly basis throughout the growing season, with the intention of verifying overflooding ratios, identifying problematic orchards, and charting the success of the program in various production areas. With such a large database, and no rapid method of spatially analyzing or portraying the data, it was decided that a geographic information system approach be adopted by the SIR program.
**Objective of Research:** In a joint, SIR and AAFC matching investment initiative project centered at PARC, Summerland, a GIS facility was developed in 1999. Base maps for orchards in zone 1 have now been completed, and all pheromone trap locations were georeferenced using GPS in 1999 and 2000. The trap location data points also contain other attribute data, including trap height, orchard type, ground cover, slope and so on. One operational objective is to produce a variety of maps to spatially observe Codling moth populations in zone 1, and ultimately to do so in a dynamic sense to facilitate the better targeting of problem areas. Research objectives include mining the data to examine Codling moth emergence (biofix) or overflooding success in orchards differing in certain production or environmental parameters. A major objective of the GIS project is to assist the SIR program in identifying consolidated areas as being of low risk in order to reduce trap numbers and reallocate various other resources to the higher risk areas.

**Results to Date:** The databases described above have been completed, and the research objectives identified will begin in November, 2000.

**Continuing Research:** This is the second year of a 3-year MII project.

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**Title 1:** Life-history traits and white abdominal discoloration in the predaceous mite, *Phytoseiulus persimilis*.

**Author and Associates:** David Raworth, Susan Bjørnson and Caroline Bédard (PARC, Agassiz)

**Problem:** Greenhouse growers have noticed a decline in the efficacy of *P. persimilis* in controlling the two-spotted spider mite, *Tetranychus urticae* Koch, and they have often associated this decline with white abdominal symptoms.

**Objective of Research:** To determine the relationship between the life-history traits of *P. persimilis* and white abdominal symptoms.

**Summary of Results:** White abdominal symptoms continually change in this predator in conjunction with egestion. Fecundity declined as the number of 4-min observations of white symptoms increased in 7-day trials; but there was no relationship between fecundity and the proportion of individuals with white symptoms on receipt of a shipment. Fecundity declined 22% and white symptoms increased from July through October.

**Continuing Research:** We will be attempting to find ways to improve the fecundity of *P. persimilis*.

**Contact:**
Title: Development of pheromone traps for the click beetles *Agriotes obscurus* and *A. lineatus*

**Author and Associates:** Bob Vernon and Elaine Goudie (PARC, Agassiz), Miklos Toth (Hungary) and Dave Wakerchuk (PheroTech Inc.)

**Problem:** Two European wireworms, *Agriotes obscurus* and *A. lineatus*, were introduced to BC a century ago, and are causing increasing damage to many crops. Sampling methods exist for the larval, or wireworm stage of this pest, but they are too time consuming and variable in efficacy for use in identifying fields that may be at economic risk. Pheromones for the adult, or click beetle stage of these species have been identified in Russia, and were evaluated in BC in prototype walk-in traps developed at PARC, Agassiz in 1999. It is hoped that these traps might provide a more accurate and less time consuming method of monitoring for use in IPM programs or for survey purposes.

**Objective of Research:** To evaluate a new walk-in pheromone trap in 16 strawberry fields throughout a growing season in the Fraser Valley of BC. To correlate catches of click beetles in pheromone traps with larval surveys in 1999 and 2000 in the same fields, and to study various parameters related to the deployment and interpretation of these pheromone traps.

**Summary of Results:** The new pheromone trap design was very effective and selective for *A. lineatus* and *A. obscurus*. For example, about 25,000 *A. obscurus* beetles were taken in 60 traps placed throughout one field between April and May. Preliminary analyses indicate that pheromone traps are generally predictive of wireworm populations in a field, but that additional information (such as summer and winter cropping history) is required for predictions to be most accurate. Spatial analysis and correlation of click beetle and wireworm captures in 16 strawberry fields is currently underway.

**Continuing Research:** Research will focus on improving aspects of trap efficacy. Traps are currently available through PheroTech Inc., and will be deployed in strawberry and potato growing regions of BC in 2001. These traps will also feature prominently in an area-wide wireworm suppression program proposed for 2001 by PARC Agassiz for the Fraser Delta of BC.

Title: Evaluating various insecticides for control of the wireworms *Agriotes obscurus* and *A. lineatus* in potatoes.

**Author and Associates:** Bob Vernon, Victoria Brookes, Anita Behringer and Elaine Goudie (PARC, Agassiz).

**Problem:** The European wireworms, *Agriotes obscurus* and *A. lineatus*, are insects of major concern to the potato industry in BC. Growers have traditionally applied granular insecticides for control of this pest, and during the past decade have relied almost exclusively on the organophosphates Thimet (phorate) and Dyfonate (fonofos). Thimet, has been withdrawn for use in BC by the parent company, however, and Dyfonate is no longer manufactured worldwide. Potato growers in BC were granted an emergency use registration for Pyrifos (chlorpyrifos) 15G in 2000, but the availability of this product or any other wireworm
control in the near future is quite uncertain. The testing of new insecticides and alternative approaches for wireworm control in potatoes is therefore a priority at PARC, Agassiz.

**Objective of Research:** Insecticides for control of European wireworms in potatoes were evaluated at two sites in the Fraser Valley of BC in 2000. Insecticidal formulations were applied to seeding furrows as granules (i.e. fonofos (Dyfonate 15G); tefluthrin (Force 3G); chlorpyrifos (Pyrifos 15G); and phorate (Thimet 15G)) or sprays (i.e. chlorpyrifos (Pyrinex); thiamethoxam (Actara 240SC), 8-cyhalothrin (Matador 120EC); and bifenthrin (Capture 2EC); or as potato seed treatments (i.e. thiamethoxam (Adage 5FS); and imidacloprid (Gaucho). Wheat seed treated with lindane (Vitavax Dual) and applied like a granular insecticide to seeding furrows was also tested.

**Summary of Results:** Potatoes from the two sites were harvested during the first two weeks in October, and are presently being graded. It is expected that results will be available by October 31, at which time the most efficacious candidates will be selected for URMULE or Emergency Use registrations.

**Continuing Research:** It is expected that this work will continue for at least one more year.

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**Title:** Development of new biological controls for the BC Greenhouse Vegetable Industry


**Problem:** Greenhouse tomato, cucumber and pepper crops in BC are grown under an IPM regime based on introduction of biological controls. Invasions of pests from outside of the greenhouse (both known and novel species) disrupts this biological control by stimulating the use of pesticides to control the invader. Establishing generalist omnivores in the greenhouse as a buffer against uncontrolled population growth in these species is a possible approach to the problem. Further, theoretical studies suggest that the presence of generalist omnivores in a community of natural enemies will tend to stabilise pest population dynamics. Previous experience suggests that it is undesirable to import exotic species of broadly generalist natural enemies. Therefore, species that are native to North America, and are widely distributed are the most appropriate candidates.

**Objective of Research:** To investigate the potential for using an omnivorous bug, *Dicyphus hesperus* Knight (Heteroptera: Miridae) as a biological control in greenhouse vegetable crops. Investigate prey acceptance, plant feeding and damage, responses to daylength, and biological control potential.

**Summary of Results:** The project was completed in the spring of 2000. *D. hesperus* accepts whitefly, mites, thrips, aphids and moth eggs and small caterpillars as prey. Results suggest that whitefly are a preferred prey. Biological control of greenhouse whitefly and twospotted spider mites on tomato crops has been demonstrated in research settings. Commercial trial releases have been equally successful. Intra-
guild predation is a concern. In laboratory conditions, the whitefly pupae parasitized by *E. formosa* are only preyed upon at the rate at which they occur in the population. *D. hesperus* expresses neither preference nor aversion to parasitized pupae. On crops, *D. hesperus* shows a preference for whitefly nymphs over pupae. Parasitized nymphs are preyed at the same rate as unparasitized nymphs. This causes a lower number of parasitoids to survive to pupation in the presence of *D. hesperus*. However, the rate of parasitism is similar between treatments with and without *D. hesperus* in whole plant experiments over a 5 week period. The spider mite predator *P. persimilis* is not apparently affected by the presence of *D. hesperus*. Predation on spider mite populations in the presence of both predators is equal to the sum of predation of the two predators in isolation, and *P. persimilis* persists in the presence of *D. hesperus* on tomato plants over a 2 week period. *D. hesperus* is a zoophytophagous omnivore, and laboratory studies show that primary function of plant feeding is to obtain water. This water is required for saliva production, which is essential to the predation process in this insect. Plant feeding does not cause damage to growth or production. On tomato, some cosmetic damage occurs on the fruit. However, this damage is within the tolerance of the grading standard for top-quality fruit at B.C. Hothouse Foods Inc. Results of season-long experiments suggest that the rate of blemishing is positively correlated with numbers of *D. hesperus* on the crop. A binomial sampling plan has been developed for *D. hesperus* on tomato crops. The population of *D. hesperus* from the interior of British Columbia enters diapause at a daylength of 15.5 hours, which restricts its use in greenhouses to the summer months in BC. A population from California has been collected and released to insectary producers for propagation and sale. This population has a critical daylength of 13.5 hours, and is relatively insensitive to daylength in the presence of favourable conditions. With a temperature of 23°C, and available prey, adults leave reproductive diapause after 1 to 3 weeks and begin ovipositing. This will permit the winter use of *D. hesperus* in greenhouses in Canada. Greenhouse trials in the presence of alternative host plants suggest that favoured host plants such as mullein, *Verbascum thapsus* can enhance the establishment of *D. hesperus* in crops in the absence of abundant prey. Greenhouse compartments with mullein plants contained almost twice the number of *D. hesperus* as compartments without.

**Continuing Research:** Although the original project is complete, research on *D. hesperus* continues, under a new project, "Integrating biological control of greenhouse pests with *Dicyphus hesperus* into the IPM systems in the BC Greenhouse Vegetable Industry." Continuing research includes: determine effects of plant communities on populations of *D. hesperus*; determine effects of temperature on development; determine effects of plant species on development and reproduction in *D. hesperus*; determine pesticide tolerances of *D. hesperus*; determine host-plant preferences and the role of plant and prey quality in predation processes.

**Title:** Biological Control of Lygus Bugs in southwestern British Columbia

**Author and Associates:** D. Gillespie, R. McGregor, D. Quiring, P. Mason H. Goulet, M. Schwartz, R. Footit, A. Luczynski

**Problem:** A number of high value crops grown in Southwestern British Columbia are attacked by one of three common species of lygus bugs, *Lygus elisis, L. shulli* and *L. hesperus*. In crops that rely heavily on IPM and use arthropod biological control agents, (e.g. greenhouse vegetable crops), applications of pesticides can disrupt natural enemy populations and cause outbreaks and crop losses. Further, this insect
flies into crops from borderlands and weedy areas, and may cause damage on invasion (i.e. the population is large enough to cause damage without going through a period of increase). Pesticides and other IPM approaches applied against Lygus bugs are only effective against the population that is present in the field, and do not prevent or reduce future problems. Therefore, application of a classical biological control agent, one or more of a number of *Peristenus* spp. (Hymenoptera: Braconidae) may be appropriate. However, inventory of native parasitoids, and determination of potential non-target effects is an appropriate first step.

**Objective of Research:** To investigate the potential for releasing one or more species of *Peristenus* against Lygus spp. in south-western BC; to evaluate existing parasitoid communities; to determine potential non-target impacts; and to conduct and evaluate releases of one or more exotic parasitoids.

**Summary of Results:** A concerted effort was made in 2000 to build on early, preliminary work. Species of *Peristenus* were collected from *Lygus* spp. and from other Miridae in south-western BC. We assisted Dr. H. Goulet (AAFC - ECORC) in a collecting trip, and continued to collect parasitized material for host association work throughout the growing season. Collected material is at ECORC, Ottawa, awaiting identification.

**Continuing Research:** This is a preliminary feasibility study and continued work will depend on regulatory environments, financial support from affected industries, and results of non-target impact studies. A second season inventory of parasitoids of *Lygus* spp. is planned.

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1. **Title**: Development of Microbial Control as a Component of IPM and Insecticide Resistance Management of the Colorado Potato Beetle.

   **Author and Associates**: Mark S. Goettel, Christine Noronha and David W.A. Hunt

   **Problem**: The Colorado potato beetle, *Leptinotarsa decemlineata*, is the most destructive insect pest of potatoes. Until recently it was managed exclusively by the use of insecticides but the beetle has developed resistance to most of the insecticides registered for its control. For the first time in western Canada, resistance has become widespread in Manitoba and is starting to appear in Alberta. In order to delay the development of resistance to newly registered insecticides, resistance management and IPM programs must be implemented.

   **Objective of Research**: To determine the effectiveness of an insect pathogenic fungus, *Beauvaria bassiana*, in reducing beetle populations and evaluate its use in an insecticide resistance management program.

   **Summary of Results**: The project commenced in 1997. Initial studies were conducted to determine the damage potential of the beetle in Alberta and to determine the extent of resistance to chemical insecticides. Untreated potato plots had yield reductions in the order of 30 to 40%. Resistance in Manitoba was widespread whereas evidence of resistance buildup was found in Alberta. Laboratory dose/mortality assays on beetles pupating in *Beauvaria* inoculated soils at different moisture levels demonstrated that the pupating larvae were highly susceptible and that moisture was important. At high concentrations, (1 x 10⁷ to 1 x 10⁸ spores/gm soil), mortality levels of greater than 90% were obtained, regardless of moisture levels between 7 and 14 %. Indications were that at higher moisture levels and lower dose (i.e. 5 x 10⁵ conidia/gm), mortality is much reduced (~20% vs. 55-70% mortality at 7-8% moisture). No mortality was obtained at a moisture level of 4%, regardless of dose.

   Adult beetles were also found to be susceptible to the fungus. Over 65% mortality was obtained 10 days after adult beetles were inoculated with 5 x 10⁵ spores/individual. Beetles allowed to dig through inoculated soil picked up spores and became infected, albeit at a low level (15%). It was demonstrated that the number of spores retained on the body surface decreased with increased depth, indicating that the digging action acted to dislodge the spores. However, none of the beetles lost all of the spores and it remains to be determined if adequate inoculum levels are retained in order to elicit disease over the duration of the overwintering period of approximately 9 months.

   **Continuing Research**: Field plots have been established in Prince Edward Island, Ontario and Alberta to evaluate the effectiveness of *B. bassiana* for inducing mortality in overwintering beetle populations. Spores were applied to the surface of the soil and at a depth of 10 cm. Emergence of adults will be monitored in the spring. Laboratory assays will continue to evaluate the importance of dose, temperature and soil type and moisture.

   **Contact**: Mark Goettel

2. **Title**: A ghost from the past - the wheat stem sawfly.

   **Author and Associates**: Brian L. Beres¹, J. Robert Byers¹, and Hector A. Carcamo¹
Problem: The wheat stem sawfly *Cephus cinctus* (Hymenoptera:Cephidae), has historically been a major pest of spring wheat in the southern prairies and the adjoining parts of the USA. The combined factors of conservation tillage practices and dry weather conditions contributed to severe infestations in 1999 and 2000, which prompted a reassessment of the resistance levels in wheat varieties grown in areas prone to attack.

Objective of Research:
- Assessment of historical and current varietal resistance to wheat stem sawfly
- Determine effects of host resistance level on the wheat stem sawfly population dynamics
- Quantify economic losses associated with sawfly damage

Summary of Results:
Cutting data from 2000 was compared to data compiled in the years 1987 - 1991.
1. The cutting data from 2000 and reports from growers indicate that wheat stem sawfly populations are on the rise and producers in areas prone to attack should make cropping choices for next year that offer the highest degree of control.
2. Yield losses attributed to sawfly can range from 6.8 to 22.4 %, and the average economic loss attributed to the wheat stem sawfly was valued at $16.44/acre in 2000.
3. Cropping systems should incorporate the use of solid-stemmed varieties such as AC Abbey or AC Eatonia. The use of solid-stemmed varieties over successive years should reduce sawfly populations as fecundity of the sawfly population is negatively correlated with the expression of solid stems.

Continuing Research:
1. Continue to assess current wheat varieties for resistance to wheat stem sawfly.
2. Determine efficacy, if any, of systemic insecticides used as seed treatments.
3. Investigate the feasibility of cropping systems utilizing trap strips of resistant varieties or mixtures of resistant and susceptible varieties.

Acknowledgements:
Excellent technical support provided by Carolyn Herle, Gary Larson, Ryan Dyck, Arne Larson and the Crop Sciences Field Crew (Lethbridge Research Centre).

Contact: Brian Beres

3. **Title:** *Lygus* species composition in canola throughout Alberta.

Author and Associates: Héctor A. Cárcamo, Michael Dolinski, Jennifer Otani, Lloyd Dosdall and Peter Mason.

Problem: In Alberta, *Lygus* species have reached pest proportions in canola in recent years but the geographic variation in species composition has not been quantified.

Objective of Research: To characterize the species composition of the *Lygus* complex in canola throughout Alberta.
Summary of Results: A survey was co-ordinated by provincial, federal entomologists and crop specialists from 1997-2000. The dominant species in the north and central regions was *L. lineolaris* but in southern Alberta *L. elisus*, and *L. borealis* were dominant in the spring and *L. keltoni* in the summer.

Continuing Research: Data on lygus bug abundance and species distribution will be used in conjunction with overwintering studies to better understand species outbreaks.

Contact: Héctor Cárcamo

4. **Title**: Effect of alfalfa harvest on lygus bug abundance in canola.

Author and Associates: Héctor A. Cárcamo, Michael Dolinski, Jennifer Otani, and John Gavloski.

Problem: Alfalfa is considered a primary host of lygus bugs and a potential source of lygus that reach pest status in canola, particularly after hay harvest.

Objective of Research: To quantify the effect of cutting alfalfa on abundance of lygus bugs in nearby canola fields.

Summary of Results: In 1998-200 L. *borealis* was the dominant species in alfalfa and its numbers never increased in canola after cutting. Increases of *L. lineolaris* in canola after cutting alfalfa were rare and can be explained by growth stage of canola rather than emigration from alfalfa.

Continuing Research: Future studies should focus on alternative hosts other than alfalfa in north and central regions and alfalfa-canola dynamics in southern Alberta where *L. keltoni* is the dominant species in canola.

Contact: Héctor Cárcamo

5. **Title**: Overwintering biology of lygus bugs and cabbage seedpod weevil.

Author and Associates: Héctor A. Cárcamo, Carolyn Herle, Rick Butts, and Jennifer Otani.

Problem: Populations of insects in the spring are determined by the size of the fall population and abiotic overwintering conditions. Knowledge of the overwintering ecology of lygus bugs and cabbage seedpod weevils will assist to predict their pest status.

Objective of Research: To determine overwintering sites, survivorship and cold hardiness of lygus bugs and csw.

Summary of Results: Both lygus and weevils overwinter mainly in tree shelters and to a lesser extent in ditches and alfalfa. Laboratory and field studies suggest that these habitats allow high survivorship since temperatures below leaf litter seldom reach lethal temperatures. Preliminary data suggested sub-lethal temperature effects on cabbage seedpod weevil reproductive potential.

Continuing Research: Field and laboratory studies will be repeated during the winter of
6. **Title**: Chemical management of lygus bugs and cabbage seedpod weevils.

**Author and Associates**: Héctor A. Cárcamo, Rick Butts, Owen Olfert and Jennifer Otani.

**Problem**: In southern Alberta, canola growers need to manage a novel insect pest complex that includes lygus bugs and cabbage seedpod weevils. Currently the only strategy available is chemical sprays.

**Objective of Research**: To determine optimum timing and frequency of insecticide applications to control lygus and csw.

**Summary of Results**: In the first experiment Deltamethrin was applied at bud, flower or pod stage and at various combinations of these stages. In a second experiment, three insecticides (Cyhalothrin-lambda, Chlorpyrifos and Deltamethrin) were applied once at the bud stage and compared with three seed treatments (Gaucho platinum, Adjust, Lindane) and an untreated check. Data have not been analyzed at the time of writing this report.

**Continuing Research**: Both studies will be repeated in 2001.

**Contact**: Héctor Cárcamo

7. **Title**: Effect of lygus bug herbivory on canola.

**Author and Associates**: Héctor A. Cárcamo, Jim Jones, Jennifer Otani and Rick Butts.

**Problem**: Lygus bug herbivory at the bud to early flower stages of canola may be compensated except when feeding pressures are too high such as that observed during outbreak years.

**Objective of Research**: To determine if lygus bug herbivory at the early growth stages affects canola yields.

**Summary of Results**: Two cage experiments were carried out: (1) herbivory by 4 lygus bugs or 0, 5, 10, 15 and 20 days per plant; (2) densities of 0, 2, 4, 6, and 10 lygus per plant. Severe drought conditions at the site (Lethbridge) severely confounded the experiment.

**Continuing Research**: The study will be repeated in 2001.

**Contact**: Héctor Cárcamo

8. **Title**: Effect of lygus and cabbage seedpod weevil combinations on canola yields.

**Author and Associates**: Héctor A. Cárcamo and Owen Olfert.
Problem: Both cabbage seedpod weevils and lygus bugs co-occur in canola and may reduce yields at densities below the economic thresholds for individual pests.

Objective of Research: To develop economic thresholds and management recommendations for cabbage seedpod weevils and lygus bugs pest combinations.

Summary of Results: Cages (0.81 m²) were used to confine 10 canola plants at the bud stage. Combinations of lygus and weevils were established at the bolting stage to reflect densities above, at or below economic thresholds as well as checks with only one or none of the two species. Results are not available at the time of writing this report.

Continuing Research: The study will be repeated at least one more year.

Contact: Héctor Cárcamo

9. Title: Trap cropping the cabbage seedpod weevil in canola.

Author and Associates: Héctor A. Cárcamo, Rob Dunn, Bob Byers, Doug Moisey and Owen Olfert.

Problem: Cabbage seedpod weevils and lygus bugs often require insecticide treatment at different stages of canola and significantly reduce growers’ margins. Alternative methods of pest control are required to reduce control costs.

Objective of Research: To concentrate and control the cabbage seedpod weevil in trap strips of earlier flowering canola.

Summary of Results: A field (640 acres) south of Taber was planted with a 30 m border of Polish canola around an Argentine main crop. Weevils were sprayed at the border during early flower when they reached 10-12 per sweep. Weevils remained below the economic threshold (less than 4/sweep) in the unsprayed main crop throughout the flower stage and at the border after spraying. Low exit hole counts (18 % infestation, i.e. less than 5% larval seed losses) in the unsprayed main crop, comprising 90 % of the field, suggest that trap cropping has potential and warrants further study.

Continuing Research: The research is expected to continue for another 3 years, pending funding.

Contact: Héctor Cárcamo

10. Title: Insect pest damage to herbicide-tolerant and conventional canolas.

Author and Associates: Héctor A. Cárcamo and Bob Blackshaw.

Problem: Insect pests have become an agronomic problem of canola, particularly in southern Alberta where the cabbage seedpod weevil has reached outbreak levels along with high numbers of flea beetles and lygus bugs. There is currently no published information comparing damage by this insect pest complex to herbicide tolerant and conventional canolas
Objective of Research: To compare abundance of flea beetles, lygus bugs, cabbage seedpod weevils and their feeding damage in herbicide-tolerant and conventional canolas.

Summary of Results: Herbicide-tolerant (Round Up Ready™, Liberty Link™) and conventional (Q2) canolas were grown without insecticide treatment and sampled for flea beetles, cabbage seedpod weevil, lygus abundance and assessed for feeding damage. Flea beetle damage was similar among the three cultivars; other results are not available at the time of writing this report.

Continuing Research: The study will be repeated in 2001.

Contact: Héctor Cárcamo

11. Research Topic: Insect pest forecasting

Author and Associates: D.L. Johnson

Problem:
Objective of Research:
Summary of Results:

Continuing Research:
a) The use of GIS in grasshopper forecasting was developed here in the mid-80's. Recent improvements in 2000 use better mapping software. We now have 30 years of data in the package and are working on a spatial analysis comparing grasshopper abundance maps to weather for AB and SK, over this period. This is part of a continuing study of the impacts of weather, climate and climate change. Communications have also improved in many ways, such as the new Internet discussion list alberta-crop-pests.

b) Development of an improved insect body temperature model was completed, for use with grasshoppers and other insects. We can more accurately predict development and feeding.

Contact: Dan Johnson

12. Research Topic: Grassland insect ecology and biodiversity

Author and Associates: D.L. Johnson

Problem:
Objective of Research:
Summary of Results:

Continuing Research: We continue to evaluate the interactions of diverse grassland life (including insects, birds, and spiders), to make use of natural enemies of pests and avoid harm to wildlife.

Contact: Dan Johnson
13. **Research Topic:** Grazing and insects

**Author and Associates:** D.L. Johnson

**Problem:**

**Objective of Research:**

**Summary of Results:**

**Continuing Research:** This year we completed the last sampling in a study of how grasshoppers respond to grazing pressure. Their numbers are highest in heavily grazed pastures, and drop off under either light or extreme grazing pressure. Species change greatly, because of preference for cover or no cover.

**Contact:** Dan Johnson

14. **Research Topic:** Biological control

**Author and Associates:** D.L. Johnson

**Problem:**

**Objective of Research:**

**Summary of Results:**

**Continuing Research:**

a) Two years of tests (in cooperation with J. Smits, Toxicology Centre, U of S) have indicated that birds sustain no harmful effects from eating grasshoppers infected with fungi. The fungi (various isolates of two species from Africa and North America) are candidates for use as grasshopper control agents.

b) Research on flies that attack grasshopper has been completed (Troy Danyk, doctorate). One aspect studied concerned impacts of chemical insecticides, and seed treatments appear to have useful integrated applications with biological control.

**Contact:** Dan Johnson

15. **Research Topic:** Ecotoxicology

**Author and Associates:** D.L. Johnson

**Problem:**

**Objective of Research:**

**Summary of Results:**

**Continuing Research:** This year we initiated tests of replacements for Vitavax seed treatment, with tests of possible impacts on leafcutter bees. Other studies involved grasshoppers and wireworms.
Preliminary sampling of aquatic insects is aimed at eventual ecotoxicological research on the impact of insecticides on non-target organisms.

**Contact:** Dan Johnson

16. **Research Topic:** Other insects

**Author and Associates:** D.L. Johnson

**Problem:**

**Objective of Research:**

**Summary of Results:**

**Continuing Research:** Wireworms, wheat head armyworm and some other new potential pests were monitored this year. The drought increased numbers of many insects this year, and also of arachnids (scorpions, spiders, etc.).

**Contact:** Dan Johnson

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**Agriculture and Agri-Food Canada**

**Beaverlodge Research Farm**

1. **Title:** *Lygus* seasonal biology in canola following bud insecticide applications.

**Author and Associates:** J.K. Otani and Héctor A. Cárcamo

**Problem:** The effect of Chlorpyrifos (Lorsban), Deltamethrin (Decis) and Cyhalothrin-lambda (Matador) applied at the bud stage on *Lygus* populations occurring in canola will be examined. This study will examine the impact of a bud application of insecticide on *Lygus*. Producers, particularly those growing herbicide tolerant varieties of canola, are interested in the effectiveness of this application period because:

1. The insecticide could be applied as a tank mix with herbicides already applied at this growth stage (i.e. reduced application costs compared to an insecticide-only application later in the season),
2. The insecticide is applied to canola prior to peak honeybee activity.

Current economic thresholds (Wise and Lamb 1998) are based on results showing that the bud is an uneconomical control period for *Lygus*. Rather, the late flower and early pod stages will produce economic advantages for canola producers. The outlined study will determine how *Lygus* populations are affected by different insecticide applied at the bud stage only.

**Objective of Research:** To examine *Lygus* reproduction and resulting populations in field plots throughout the canola growing season following the application of foliar insecticides at the bud stage.

**Summary of Results:** In 1999, bud insecticide applications occurred on 9 July (3.2 growth stage, Harper and Berkenkamp 1975). Low populations (<10 *Lygus* per 10 sweeps) were present in plots treated with Cyhalothrin-lambda throughout the late flower and early pod stages. However, populations of *Lygus* in plots treated with Chlorpyrifos did exceed the economic threshold (Wise and Lamb 1999) at
the early pod stage at both the Beaverlodge and Dawson Creek study sites. Although *Lygus* populations did differ significantly between treatments, the yield was not significantly different. Drought affected the both study sites in 1999 and this would have reduced potential yields.

In 2000, the study was expanded to include Deltamethrin (Decis). *Lygus* populations are still being assessed and yield data is not available yet. In general, high populations of *Lygus* were present in control plots and better growing conditions were present in both study sites for this field season.

**Continuing Research:** This study will be repeated in the 2001 field season.

**Contact:** Jennifer Otani

2. **Title:** Insects in fall seeded, Round-Up Ready canola grown in the Peace River Region.

**Author and Associates:** J.K. Otani and J. O'Donovan

**Problem:** *Lygus* are a major insect pest of canola in the Peace region. There is evidence that earlier emerging Polish canola grown in the Peace attracts higher populations of *Lygus* than Argentine canola (Butts 1989). Fall seeded Argentine canola and Polish canola should emerge earlier in the growing season relative to spring seeded Argentine. However, *Lygus* may be attracted earlier and in greater densities to the fall-seeded canola. High densities of *Lygus* can affect canola development and time to maturity, yield, and seed quality. In addition, other insect pests of canola in the Peace region include Cabbage root maggot, Bertha armyworm and crucifer and striped flea beetles. These insect pests need to be monitored to determine if fall seeded canola will escape or attract insect pests. The insect pest potential in fall seeded canola grown under short season conditions found in the Peace River Region needs to be assessed in order to prepare producers who are choosing to move to this new agronomic practice.

**Objective of Research:** To determine if infestations of *Lygus* and other insect pests are affected by the early phenology that fall seeded canola provides and by the management practice used to improve yield.

**Summary of Results:** Two insect species were targeted for insect collections in 2000. Flea beetle populations were high in both sites so feeding damage at the cotyledon stage was recorded in Beaverlodge on 25 May and in Fort Vermilion on 1 June. In general, flea beetle feeding damage did not exceed 25% of the cotyledon leaf area in any treatments and no additional insecticide treatment was required other than Vitavax (lindane) applied as a seed treatment.

*Lygus* were present in all sweep-net collection periods in study locations (Beaverlodge and Fort Vermilion). Insects collected by sweep-net will be sorted, identified, and counted between September and January 2001. Initial observations suggest that numbers of *Lygus* exceeding the current economic thresholds were present in both locations.

**Continuing Research:** This study will be repeated in the 2001 field season.

**Contact:** Jennifer Otani
3. **Title:** Lygus bug oviposition behaviour, egg mortality, and recruitment of nymphs to adults in canola treated with Imidacloprid (Gaucho®).

**Author and Associates:** J.K. Otani, J. Huffman, NPARA, Gustafson

**Problem:** A seed insecticide treatment with systemic activity (Imidacloprid [Gaucho® 480FL]) targeting Flea beetles (*Phyllotreta cruciferae* Goeze and *P. striolata* Fabricius), might affect lygus bugs populations. Preliminary observations by Gustafson and Alberta Agriculture, Food and Rural Development suggest that lygus bug populations are lower in canola stands treated with Imidacloprid (Gaucho® 480FL) than in stands treated with Lindane (Vitavax® RS). The activity of Imidacloprid, a seed-applied, systemic insecticide, may interrupt lygus bug reproduction and recruitment of damaging populations by affecting oviposition by adults or nymph development resulting from oviposition by adults.

The proposed research will examine lygus bug populations under greenhouse conditions. Specifically, this study proposes to introduce adults to seed treated canola and examine the resulting oviposition and nymph populations to determine if seasonal reproduction and the phenology of this pest insect is affected by the application of Imidacloprid.

**Objective of Research:**
- To examine lygus bug oviposition behaviour in canola.
- To examine lygus bug oviposition behaviour, egg mortality, and recruitment of nymphs to adults in canola treated with Imidacloprid (Gaucho®).

**Summary of Results:** Experiments still in progress in the lab.

**Continuing Research:** This study will be repeated in 2001.

**Contact:** Jennifer Otani

4. **Title:** The effect of insecticide and fall raking on silvertop control in a commercial stand of Creeping red fescue.

**Author and Associates:** J.K. Otani

**Problem:** Silvertop is a major problem in fescue fields in the Peace River Region and can cause economic losses when abundant in the field. Silvertop is a common name for a condition where the terminal, beginning at the penultimate node of the plant stem and including the seed head, bleaches out after emerging from the boot. The bleached portion of the stem appears whitish and is easily detached from the stem. Affected stems break easily or detach from the leaf sheath and either no seed or sterile seed is produced in the head. Insects are associated with silvertop. These include *Capsus cinctus*, *Labops*, *Stenodema vicina*, *S. trispinosa*, and *Litomiris debilis* and all these species are present in the British Columbia Peace River Region (Arnott and Bergis 1967).

The goal of this research project is to develop a management strategy to control silvertop in susceptible grass seed crops. This work will help to provide guidelines in crops that have few registered products and will provide research results to producers and the seed industry. A better understanding of the
relative impact of insects on silvertop will lead to more effective control tools and economic returns for producers.

**Objective of Research:** To determine the effect of chemical and cultural control techniques on insect populations and resulting silvertop levels in commercially grown grass seed crops.

**Summary of Results:** In general, low levels of silvertop were present in the commercial fields selected in both 1999 and 2000 (Baldonnel, BC). In 1999, two periods of insecticide application were compared for their effect on silvertop levels in a Creeping red fescue stand. Deltamethrin (Decis) was applied to plots 19 May and 2 June (12.4 g Al/ha) in 1999. The resulting silvertop levels did not exceed 5% per 0.25m² in either treated or untreated plots. However, several insect species previously identified in silvertop fields were present in 1999 study plots; two mite species, *Labops* spp., *Capsus* spp., *Stenodema* spp., and several species of leafhoppers, froghoppers, and spittlebugs were present in sweep-net collections. In 2000, Deltamethrin applications were made to plots on 3 May and 24 May. Insect, yield and silvertop data from the 2000 field season is still being recorded. More data from this study should be available in January.

**Continuing Research:** This study will be repeated in the 2001 field season.

**Contact:** Jennifer Otani

5. **Title:** Cultural and chemical control of silvertop in Sheep fescue.

**Author and Associates:** J.K. Otani

**Problem:** Silvertop is a problem in fescue seed crops and some grass species are more susceptible to it than others. Sheep fescue, *Festuca ovina* (L. ssp. hirtula [Hackel ex Travis] Wilkinson), is a species of fine fescue that is susceptible to silvertop. The cause or causes of silvertop are not understood. This work will provide information on the incidence of silvertop in the Peace River Region and provide recommendations to producers and to the seed industry on how silvertop might be controlled. It is intended to provide information on cultural and chemical strategies for silvertop control in fescue seed crops.

**Objective of Research:** To determine the effect of mowing, raking and application of Cyhalothrin-lambda (Matador) on silvertop control in a commercial stand of Sheep fescue grown in the Peace River Region.

**Summary of Results:** This was the first year of this study. Yield and silvertop data from the 2000 field season is still being recorded. In general, visual lines of silvertop control were observed in Sheep fescue plots following the application of the insecticide. Neither mowing nor raking produced the same visual lines of control. However, yield and percent silvertop incidence has not been completed at the time of reporting. Data from this study should be available in January.

**Continuing Research:** This study will be repeated in the 2001 field season.

**Contact:** Jennifer Otani

6. **Title:** Silvertop and stem eyespot control in Creeping red fescue.
Author and Associates: J.K. Otani and H. Klein-Gebbinck

Problem: Stem eyespot, caused by *Didymella festucae*, is responsible for major yield losses in fescue seed production. The etiology of the disease is not fully understood. There are two proposed modes of stem eye spot infection (ascospore and pygnidiospores). Initial infection occurs on the leaf sheath by ascospores from infected debris from the previous year. As the head emerges from the protective boot, mycelium grows from the leaf sheath to the head and stem as it elongates. It is also possible that infection may occur directly from ascospores deposited onto the elongating stem following emergence. Secondary infections may arise from pygnidiospores that are likely dispersed by rain splash and/or insects.

Quadris is not currently registered for Stem eyespot control in Creeping red fescue seed production in Canada. However, this chemical has been used experimentally in the US for control of fungal diseases in grass seed production. Use in the US has spurred interest and questions from Canadian growers who regularly deal with Stem eye spot in high value fescue seed crops.

Objective of Research: To examine the development of stem eye spot occurring in commercial stands of Creeping red fescue stands grown in the Peace River Region.

Summary of Results: Yield, silvertop and stem eye spot data from the 2000 field season is still being recorded. In general, low levels of silvertop were present in the commercial field selected for the study (Baldonnel, BC). Although, high levels of stem eye spot were observed in the plot areas. Data from this study should be available in January.

Continuing Research: This study will be repeated in the 2001 field season.

Contact: Jennifer Otani

7. Title: Arthropod survey in clover seed production.

Author and Associates: J.K. Otani and C. Yoder

Problem: Clover seed crops have become increasingly more valuable in the seed market. Several insect pests including the alfalfa weevil, pea aphid, alfalfa plant bug, Lygus bug, and alfalfa looper are present in clover. Each year, insecticides are applied to protect yield and seed quality in clover seed stands however the effort and timing of sampling to determine insect pest potentials needs to be address in the Peace River Region. An insect survey will be performed with the objectives of identifying major insect pest species and their seasonal distributions. This data will assist clover seed producers in identifying insect pest species, sampling periods for monitoring and potential control periods available within the short-season growing conditions found in the Peace River Region.

Objective of Research: To determine the species of potential pest insects and their phenology in clover seed crops grown in the Peace River Region.

Summary of Results: Sweep-net collections were completed in the Falher, Alberta regions in commercial fields of clover grown for seed 8 June, 20 July, and 8 August. Unfortunately, cool and wet weather interfered with collections. All insects were preserved and no data is available at this time.
Continuing Research: This study will be repeated in the 2001 field season.

Contact: Jennifer Otani

Alberta Agriculture, Food and Rural Development
Agronomy Unit

1. **Title:** Does Canola Compensate for Lygus Damage?

**Author and Associates:** J.W. Jones¹, H.A. Carcamo², J.K. Otani², R.A. Butts², R.H. McKenzie¹, E.D. Solberg¹, J. DeMulder¹

¹ Alberta Agriculture, Food and Rural Development
² Agriculture and Agri-Food Canada

**Problem:** *Lygus* spp. infests canola after buds form. Damage is caused by their feeding from bud stage through to harvest. Economic thresholds are available for late flowering and pod stages but not for bud and early bloom. Significant populations of lygus are sometimes present in budding canola and insecticides have been applied to severe infestations. The questions asked in this research are directed at whether and how canola compensates for lygus feeding in these earlier stages.

**Objective of Research:** To determine the effect of lygus feeding on canola yield and other components of plant compensation during the bud to early bloom period by manipulating: (i) lygus infestation rate, (ii) lygus infestation duration, (iii) sulphur fertility.

**Summary of Results:** We have completed the second year of this three year project. Experiments were conducted at Lethbridge, Ellerslie, Muir Lake and Beaverlodge.

**Continuing Research:**

**Contact:** Jim Jones

2. **Title:** Integrated Pest Management in Short Rotation Canola.

**Author and Associates:** K. Topinka¹, P. Kharbanda², R. Lange², J. Jones¹, L. Hall¹

¹ Alberta Agriculture, Food and Rural Development
² Alberta Research Council

**Problem:** The current recommendation is for canola to be grown in one year of a four year rotation, based on an understanding of the longevity of disease organisms and on risk assessments for pests. Growers are under strong economic pressure to shorten canola rotations which causes weed population shifts toward harder-to-control weeds, increases disease inoculum and likely increases the risk of crop loss due to pests generally.

**Objectives of Research:** (1) Compare weed populations; disease levels and insect infestations in four rotations for four years to determine if shortened canola rotations are possible without increased risk.
(2) Determine the interactions between disease, insect and weed populations and their effects on canola yield. (3) Compare weed, insect and disease infestations in three agro-ecological areas and determine the contributions of site and environment to pest problems in canola grown in various rotational intervals.

**Summary of Results:** This is the final year of a four year project being conducted at Strathmore, Ellerslie and Warburg. Over the course of the project, weed populations have begun to shift in response to herbicides and rotations. Directional weed shifts over the course of the experiment at all sites will continue to provide information about the selective pressure being placed on weed populations by various herbicides, selective and non-selective. Studies of root maggot damage showed 45A71 suffered consistently higher damage over 1997 and 1998; that 1-in-2 year rotations were most heavily damaged and that incidence of root rot (*Fusarium* spp. and *Rhizoctonia solani*) and maggot damage severity are linked across years and sites. The year 2000 provided our first opportunity to directly compare all rotations in this four-year cycle. Analyses of flea beetle damage data have shown that plots of canola grown continuously for four years suffered significantly more damage from flea beetles than did plots in the other rotations.

**Continuing Research:** At this point in the project, the emphasis is on compiling results from the four years, integrating analyses and preparing final reports and scientific papers.

**Contact:** Jim Jones

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3. **Title:** Maximizing Barley Production by Variety Selection and Nutrient Management.

**Author and Associates:** R.H. McKenzie¹, E.D. Solberg¹, G.W. Clayton², L.M. Kryzanowski¹, L.M. Hall¹, J.W. Jones¹

¹ *Alberta Agriculture, Food and Rural Development*
² *Agriculture and Agri-Food Canada*

**Problem:** With barley silage grown under optimum fertility management, varietal differences can exceed two tonnes / ha. Dramatic improvements in grain yields under optimum fertility management may also be feasible.

**Objective of Research:** The fourth and final year of this study has been completed. The objective of the study is to evaluate a number of commonly grown and new barley varieties under varying nitrogen management treatments to assess yield potential and agronomic characteristics in various agro-ecological areas of Alberta. One component of this study is an examination of the response of barley thrips (*Limothrips denticornis*) to barley varieties.

**Summary of Results:** Populations of barley thrips were found to vary significantly amongst locations and varieties tested. Over all years and sites, Falcon, six-row hulless barley, had highest thrips numbers, while CDC Fleet, a general purpose variety, had the lowest. Significantly higher populations were present in the high fertility treatment. Significantly higher populations were associated, too, with black zone soil sites; lowest populations were found on grey wooded soils and at the irrigated dark brown soil zone site.

**Contact:** Jim Jones
Alberta Agriculture, Food and Rural Development
Crop Diversification Centre - North

Note: Kris Pruski is on educational leave. Please refer to Alberta Research Council section for additional summaries submitted by co-applicant, Ken Fry.

1. **Title:** Management Approach in Control of Root Maggots in Cabbage Crops in Alberta.

**Author and Associates:** Kris W. Pruski, Kwesi Ampong-Nyarko, Belinda Choban, Lloyd Dosdall, Mark S. Goettel, Kenneth Fry, Jamie Motta, Nadia Geschke

**Problem:** The cole crops (mainly cabbage, cauliflower and broccoli) are major field vegetables grown in Alberta. The current production area is estimated at over 2,000 acres. However this production falls short in supplying the local demand for these vegetables; thus Alberta relies on imports. The project was undertaken in response to vegetable growers’ demands to find an effective strategy to control root maggots in cole crops. The root maggot fly, *Delia radicum*, is causing considerable damage to cole crops and under a heavy infestation of the insect, 50% crop loss is not uncommon. Heavy root maggot infestations were observed over the last three growing seasons in Alberta. Cabbage root maggots damage and destroy root systems of all cole crops, riddling roots with tunnels. Tunnels provide entryways for other pathogens that cause blackleg and bacterial soft rot. Youngest plants are most susceptible; healthy plants attacked after they are well established can usually tolerate moderate infestations. Growers are encountering difficulties to control the insects using registered pesticides or accepted, traditional practices. Also proper timing and frequency of application is often a problem; and some pesticides are no longer effective or no longer available (dasanit, for example).

**Objective of Research:** The main goal of the project is to develop an integrated pest management strategy using chemical, biological and cultural control methods for managing root maggots.

**Summary of Results:**

The study was carried out at CDC North, Edmonton. Treatments consisted of a factorial combinations of control agents (Control, Garlic Barrier (spray) - GBS, Garlic Barrier (soil drench) - GBD, GBS + GBD, Lorsban 4E, Lorsban 4E + GBS, Lorsban 4E 2x + GBS, Larvanem 100, Larvanem 100 + GBS, *Beauvaria bassiana* (granular) BbG, *Beauvaria bassiana* (powder) BbWP) three cultivars and two times of planting (early and midseason). The root maggot fly occurrence was considerably lower in late planted cabbage than in the early planting. The lowest number of eggs per plant was observed in Garlic Barrier combination of soil drench and weekly sprays with Lorsban 4E treatments. Significant differences were observed between varieties in susceptibility to insects. Early Stokes 711 was the most attractive to root maggot flies. The highest yield was recorded in Garlic Barrier combination of soil drench and weekly sprays with Lorsban 4E treatments. Survivor was the variety which produced the heaviest heads (2.5kg/head) Discovery (1.8kg/head) and Early Stokes 711 (0.94kg/head). The least damage in cabbage heads from root maggots was observed in Garlic Barrier, foliar spray and soil drench separate treatments Cabbage heads quality in treatments with entomopathogenic fungus, *Beauvaria bassiana*, was excellent with Stokes Early 711 variety. Data from both, 1998 and 1999 seasons, suggest that beside the regular chemical insecticide treatment the alternatives such as Garlic Barrier, entomopathogenic fungus and nematodes can be used effectively providing a satisfactory level of control against root maggot damages.
Continuing Research:
1. To develop economic threshold for root maggots in cabbage in central Alberta. This would help in determining the most effective time to apply control measures for the insect.
2. To refine and duplicate results obtained so far on the efficacy of the entomopathogenic nematode, Garlic Barrier as a management tool for root maggots on cole crops. This study will help in determining an application rate, method, optimum levels required for controlling the root maggot in central Alberta.
3. Evaluate the efficacy of neem as a management tool for root maggots on cole crops. Neem is a botanical insecticide of the liminoid class extracted from the neem tree.
4. Assess impact of root maggot IPM through collaborative testing of promising IPM components developed over the last three years with growers. The IPM components will include economic thresholds, cultivar, garlic barriers, nematodes and neem. The study will assess the profitability, feasibility and compatibility of recommendations.

Contact: Kwesi Ampong-Nyarko

2. Title: Control of Tarnished Plant Bug (Lygus lineolaris) and Western Flower Thrips (Frankliniella occidentalis) in Strawberries and Saskatoons in Alberta- IPM Approach.

Author and Associates: Kris W. Pruski, Kenneth Fry, Kwesi Ampong-Nyarko, Mike Hardman, Mark S. Goettel, Nadia Geschke

Problem: The berry fruit industry in Alberta is a multimillion venture, with strawberries (Fragaria x ananassa Duch) being the largest commodity and saskatoons (Amelanchier alnifolia Nutt.) becoming a second. Insects and mites constitute major threats to strawberry and saskatoon producers, reducing yields or berry quality by direct injury to roots, leaves and fruits or by indirect effects, as in the case of viruses disseminated by aphids (Shanks 1981). For many years, the strawberry industry has relied on chemicals to control the pests. Saskatoon berry growers have only two insecticides registered for their crop and none of them deals with tarnished plant bug. Tarnished plant bugs cause a distinctive concentration of achenes at the apical end of strawberry receptacles, with an accompanying lack of development. Such fruit, called “nubbins” or “buttons”, may constitute a large percentage (up to 60%) of the total fruit when tarnished plant bug populations are high. In Alberta, a steady increase in tarnished plant bug populations in strawberry and saskatoon fields has been observed over last several years. Some plantations reported heavy infestations in 1998 and 1999. Both, strawberry and saskatoon growers expressed their concerns about tarnished plant bug infestations. The other insect on the rise in Alberta strawberry plantations is western flower thrip. Western flower thrips cause fruit russetting around the calyx and, when feeding on strawberry blossom may also cause the stigmas and anthers to turn brown and wither.

Objective of Research: To examine the effectiveness of Beauvaria bassiana against tarnished plant bug in strawberries and saskatoos and against thrips in strawberries, which immediately will provide growers with an alternative control.

To examine and adapt to Alberta conditions IPM methods developed and used in Eastern Canada. This could also lead to a development of so called “second stage IPM”, where insects are chemically controlled in early season and cultural and biological controls are applied in mid and late season.

Summary of Results:
Two experiments were conducted in strawberries from April to September 2000 at CDC-North Edmonton. Twenty strawberries plants were grown enclosed in fine screen mesh. At flowering lygus plant bugs and flower thrips were released into the cages. Treatments consisted of 3 rates of Beauvaria bassiana, and the insecticides, matador, endosulphan, Avid, Admire, Actara and untreated control. There were no significant differences between treatments and the number of thrips and lygus at seven days after application.

Continuing Research
1. Examine IPM methods developed in and for Eastern Canada in Alberta conditions.
2. Develop an effective IPM or a “second stage IPM” method for Alberta conditions.
3. Develop an effective insect monitoring system for growers in Alberta (possibly including economic thresholds.

Contact: Kwesi Ampong-Nyarko

3. Title: Neem as a component of bio-intensive integrated pest management for greenhouse crop production.

Author and Associates: Kwesi Ampong-Nyarko, Andre Belanger, Mohyuddin Mirza

Problem: The tree Azadirachta indica, commonly referred to in many countries as the neem tree, is a member of the Meliaceae family. Of primary interest to research scientists is its activity as an insecticide. To date over 450 species of insects belonging to 15 orders, as well as several species of mites and nematodes are affected by this tree’s extracts. Insects that have become resistant to synthetic pesticides are controllable with these extracts. With the continued robust growth of the global biopesticide market, azadirachtin is uniquely positioned to become a key insecticide to expand in this market segment. Key pests such as whiteflies, leafminers, fungus gnats, thrips, aphids, caterpillars, beetles, mushroom flies, mealybugs, gypsy moths and others on food, greenhouse crops, ornamentals and turf. Azadirachtin has minimal to no impact on non-target organisms, is compatible with other biological control agents and has a good fit into classical integrated pest management. Azadirachtin is registered in the United States as a general use pesticide with a toxicity classification of IV (relatively non-toxic).

Objective of Research: The goal of the project is to develop and promote the use of the biopesticide neem as a component of bio-intensive IPM for greenhouse and organic horticultural crops.

Summary of Results: Activities initiated in September 2000. Industry already shown interest in possibility of commercializing neem based pesticides.

Contact: Kwesi Ampong-Nyarko

Alberta Agriculture, Food and Rural Development
Industry Development

1. Title: Canola Seed Treatment Technology Comparison.

Author and Associates: John Huffman, Lloyd Dosdall, Jennifer Otani, NPARA, and SARDA
Problem: In northern Alberta, damage from lygus bugs in canola can range from two to five per cent yield loss and can range to as high as a 30 per cent loss in yield (Butts & Lamb 1991). In addition to yield loss in canola, lygus bug feeding can result in lesions on stems, buds, flowers and pods (Huffman pers. obs.). Bud and flower blasting is common with early infestations of lygus bugs (Huffman pers. obs.). With ample precipitation, a canola plant will compensate for some blasting by producing new buds. However, under drought conditions, plants suffering blasting cannot compensate with new buds. Work done in southern Manitoba found that canola grown under stress, i.e., <100 mm precipitation from bud stage to late pod stage, could not compensate for lygus bug damage and yields were reduced resulting in economically significant losses (Wise and Lamb 1998).

Canola producers in the prairie provinces presently apply broad spectrum, foliar-applied insecticides to control lygus bugs when the economic threshold (Wise and Lamb 1998) is exceeded. However, alternative control techniques are becoming available with the development of new seed treatment products such as Imidacloprid (Gaucho®), Helix®, and Adjust®. These systemic insecticides are marketed to replace products incorporating lindane, used to control Crucifer and Striped flea beetles (Phylotreata cruciferae and P. striolata) in canola at the cotyledon stage, however these same products may also control lygus bugs. Research conducted at Washington State University showed control of cabbage seed pod weevil and cabbage aphid was possible into the early pod stage of canola development using Imidacloprid as a seed treatment (Bragg & Burns, 1998; 1999). Initial studies by Huffman et al. (1999, unpublished data) have found similar results on lygus bugs in the Peace River Region. The potential benefits of using seed insecticide treatments to control lygus bugs are elimination of errant drift associated with foliar applications and reduced mortality of beneficial insects normally present in the canola canopy. Depending on product used, smaller quantities of active ingredient may be applied per treatment when using seed-applied compared to foliar-applied control strategies.

Objective of Research:
1. To determine the effect of seed insecticide treatments on the seasonal biology of lygus bugs occurring in canola.
2. To determine the yield and quality using new seed treatment technology.
3. To determine the effect of seed insecticide treatments on the reproductive recruitment of lygus bugs occurring in canola.

Summary of Results: This is the first year of this project.

Continuing Research:

Contact: John Huffman

Alberta Agriculture, Food and Rural Development
Pest Prevention and Management Unit

1. Title: The Effect of Fall Seeding of Canola on Insect Pest Infestations

Author and Associates: L. Dosdall, P. Conway, G. Clayton, N. Harker, K. Fry
Problem: Over the past few years, the acres under production to fall-seeded canola have increased substantially primarily because polymeric seed coatings are now commercially available to prevent germination in fall. The practice is being undertaken on an extensive scale without previous research to evaluate its effects on insect pest infestations. Insects respond to the timing in availability of host plants, so it is possible that fall seeding of canola could affect infestation levels of flea beetles, root maggots, and lygus bugs.

Objective of Research: To investigate the effects of fall seeding of canola on infestations of flea beetles and root maggots.

Summary of Results: The project was initiated in 1998. Results have shown that emergence of fall-seeded crops usually precedes invasion by significant population densities of flea beetles: by the time that crops are invaded by vast populations of flea beetles, plants are usually in the true-leaf stages and can better compensate for flea beetle attack. Infestation levels of root maggots on fall-seeded canola have been variable: in some years and in some sites, root maggot infestations have been higher in fall-seeded canola than in spring-seeded plots, but in other sites and years the opposite relationship was observed. There is no evidence that fall seeding of canola automatically predisposes canola plants to increased infestation levels of root maggots.

Continuing Research: Future research will focus on assembling a larger data set for flea beetles in fall-seeded canola, and will also focus on determining the effect of fall seeding of canola on infestation levels of cabbage seedpod weevil. I will also work collaboratively with Dr. Fry to obtain information on the responses of thrips to fall seeding of canola.

Contact: Lloyd Dosdall

2. Title: Biology and Control of the Cabbage Seedpod Weevil in Canola


Problem: Populations of cabbage seedpod weevil (Ceutorhynchus assimilis Paykull) (Coleoptera: Curculionidae) have increased dramatically since the species was first found infesting canola in Alberta in 1995. Significant damage to flower buds is caused by overwintered adults, and larval feeding on developing seeds exacerbates the problem. Larval exit holes may be invaded by fungal pathogens, with damage to many more ripening seeds. Late in the season, new generation adults feed on ripening pods, also causing significant crop damage.

Objective of Research: To develop and field-test cultural, chemical, and biological control strategies for cabbage seedpod weevil in canola.

Summary of Results: The project was initiated in 1998. Results have shown that several insecticides now registered for other canola insect pests are also effective against cabbage seedpod weevil in canola. Delaying seeding date may reduce infestation levels of weevils in canola. Adult weevils invade the crop in the bud stage and maximum abundance occurs in early flowering. Differences in susceptibility to infestation by cabbage seedpod weevil occur among and within species of Brassicaceae. Alberta populations of cabbage seedpod weevil are virtually non-parasitized. The distribution and abundance of cabbage seedpod weevil have increased from 1997-2000: the species now occurs as far east as
Continuing Research: Future research will focus on co-ordinating an interdisciplinary international research group to facilitate biological control of the cabbage seedpod weevil in canola. In addition, studies are underway to screen germplasm of Brassicaceae for susceptibilities to weevil attack, and to investigate the integrated effects of seeding date, seeding rate, and canola cultivar on infestation levels of this pest in canola.

Contact: Lloyd Dosdall

Alberta Research Council

1. **Title**: Evaluation of the Fungus *Beauvaria bassiana* for Management of Western Flower Thrips.

   **Author and Associates**: Ken Fry, Mark Goettel, and Andrew Keddie

   **Problem**: The Western Flower Thrips (WFT), *Frankliniella occidentalis* (Pergande), is a major pest of greenhouse vegetable and ornamental crops. Many populations of WFT are resistant to several classes of chemical insecticide and since the passing of the FQPA in 1996, those chemicals with any remaining efficacy are under review and may be lost to the greenhouse industry. Alternative management tools are necessary for maintaining IPM programs against WFT.

   **Objective of Research**: Screen isolates of *Beauvaria bassiana* in a laboratory bioassay system to assess pathogenicity against Green Peach Aphid (GPA), WFT, and Tarnished Plant Bug (TPB) to identify promising isolates for commercialisation.

   **Summary of Results**: Ten isolates were screened at 15, 20, 25, and 30°C against WFT. 10 isolates were screened at 20°C against GPA and TPB. Three isolates caused significantly more mycosis in all three insect species and at all temperatures, excluding 30°C, than a commercially available strain.

   **Continuing Research**: The most promising isolates will be screened against common biological control organisms for pathogenicity and sub-lethal effects to evaluate the possibility of incorporation into an integrated management system in greenhouse production.

   **Contact**: Ken Fry

2. **Title**: Survey of Thrips in Canola.

   **Author and Associates**: Ken Fry, Lloyd Dosdall

   **Problem**: During intensive sampling for *Lygus* spp. in canola, moderate to high populations of thrips were observed on canola. Several anecdotal reports of pod curling, coupled with the sampling data highlighted a lack of information regarding species composition, distribution and density of thrips in canola and what impact thrips have on plant health and yield.
Objective of Research: To survey canola fields to determine species composition, distribution and density of thrips throughout Alberta and to sample from experimental plots to determine time of infestation, species composition, density and distribution in *Brassica napus* and *B. rapa* at different seeding rates and dates.

Summary of Results: Of 35 fields sampled, it was determined that the most common species of thrips associated with canola are *Thrips vulgatissimus* Haliday, *Frankliniella occidentalis* (Pergande), *F. tritici* (Fitch) and *Thrips tabaci* Lindeman. Thrips were most commonly found at bud and flower stage, with few found at pod stage.

Continuing Research: Laboratory and field studies will be conducted to determine the economic impact thrips have on canola.

Contact: Ken Fry

3. **Title:** Evaluation of Entomopathogenic Nematodes and Fungi for Management of Woolly Elm Aphid.

**Author and Associates:** Ken Fry, Kris Pruski

**Problem:** The Woolly Elm Aphid (WEA), *Eriosoma americanum* (Riley), is considered by saskatoon growers to be the most serious insect pest attacking saskatoon seedlings. Prior to 1994, there was very little known about the biology of the WEA and few methods for managing WEA existed.

**Objective of Research:** To test the effectiveness of one species of commercially available entomopathogenic nematode (EPNs) and one commercial preparation of the entomopathogenic fungus, *Beauvaria bassiana* against WEA. To examine the impact EPNs have on non-target species in saskatoon berry orchards.

**Summary of Results:** Data are currently being analysed.

**Continuing Research:** More intensive sampling will be conducted in conjunction with nematode treatments to determine the impact of EPNs on predator populations associated with saskatoon berry orchards.

**Contact:** Ken Fry

4. **Title:** Evaluation of a Baculovirus Against Bertha Armyworm in Canola.

**Author and Associates:** Ken Fry, Lloyd Dosdall, Andrew Keddie, and Martin Erlandson

**Problem:** Bertha Armyworm (BAW), *Mamestra configurata* Walker, is a periodic pest of canola across the prairie provinces. Current pest management practices are limited to chemical insecticides, which are costly both economically and environmentally.

**Objective of Research:** To test the effectiveness of 3 isolates of a baculovirus specific to BAW on canola. To assess interplot movement of BAW in canola field plots.

**Summary of Results:** Results from two years of field cage trials indicate no significant difference between viral isolates in their effectiveness in killing BAW. Mortality due to virus ranged from 80-96% in post-
application bioassays and 82-93% 14 days post-application. BAW were not observed to move in significant numbers between plots separated by 1m of bare earth.

**Continuing Research:** Large-scale un-caged field trials are planned for 2001-2002.

**Contact:** Ken Fry

5. **Title:** Survey of Insects Associated with Hemp in Alberta.

**Author and Associates:** Ken Fry

**Problem:** The amount of acres seeded to hemp in 1999 increased several-fold across Canada. Anecdotal records abound indicating many traditional cereal and oilseed crop insect pests are capable of feeding on hemp. There is currently no reliable census of insects associated with hemp in Canada. A significant amount of research on agronomic practices, insect pests and plant diseases is required to support the development of hemp as a viable crop.

**Objective of Research:** To survey the insect fauna associated with hemp in Alberta.

**Summary of Results:** Sweep-net, aspiration and pan-trap samples have been collected during the entire growing season for 1998 and 1999 in a 10-acre hemp plot. The trap residues have not been completely analysed. However, *Lygus* spp. were found in abundance in the flowers and seeds.

**Continuing Research:** Insect trap residues are to be analysed over the winter.

**Contact:** Ken Fry

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Title: Evaluation of Products for Control of Cottonwood Leafmining Beetle

Author and Associates: Don Reynard and Vaughan Williams

Problem: The cottonwood leafmining beetle, Zeugophora scutellaris has the potential to reduce the annual growth of hybrid poplar stooling beds that are used for cutting production at the Shelterbelt Centre. On ornamental poplar, the mined leaves are unsightly and reduces the aesthetic value of the tree.

Objective of Research: To determine the efficacy of acephate (Tomen Corp.), dimethoate (Cyanamid Canada Inc.) and imidacloprid (Bayer Inc.) for control of the cottonwood leafmining beetle on poplar.

Summary of Results: All three products provide excellent control of the cottonwood leafmining beetle on poplar in comparison to the water check.

Continuing Research: No further research is anticipated on the cottonwood leafmining beetle.

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The alfalfa leafcutting bee, *Megachile rotundata*, is an important pollinator of alfalfa for seed production. Infestations of a chalcid parasitoid, *Pteromalus venustus*, are currently a major problem in Saskatchewan alfalfa leafcutting bee populations. Another factor which may limit alfalfa leafcutting bee production is chalkbrood disease, *Ascosphaera aggregata*, and the occurrence of the related fungal pathogen *Ascosphaera larvis*, which has recently been identified in Saskatchewan alfalfa leafcutting bee populations. Several stored-product pest insect species have also been identified in Saskatchewan alfalfa leafcutting bee populations.

**Objective of Research:**
This research project is designed to evaluate parasitoid, predator, and disease levels in Saskatchewan alfalfa leafcutting bee populations, to identify potential problems in these areas, and to develop management strategies which will assist alfalfa seed producers in maintaining high quality alfalfa leafcutting bee populations.

**Summary of Results:**
Occurrence of a chalcid parasitoid, *P. venustus*, was evaluated in the 1999/2000 winter survey of alfalfa leafcutting bee populations in Saskatchewan. The chalcid parasitoid was detected in 1.26% (sd 1.93, range 0.0-6.95%) of bee cells analysed from samples submitted by alfalfa seed producers and this chalcid parasitoid was present in 69.2% of alfalfa leafcutting bee populations surveyed.

Chalcid parasitoids have traditionally been controlled during bee incubation with dichlorvos-impregnated resin strips; however, dichlorvos has been implicated in leafcutting bee mortality and it is also one of the organophosphate insecticides which is currently under review by the EPA. In order to develop an alternative to dichlorvos, research has been undertaken on compounds including pyrethrin aerosols, spinosad, garlic barrier, and CO₂ gas. Field-scale experiments with two pyrethrin aerosol formulations in highly parasitized alfalfa leafcutting bee populations was undertaken during the 2000 field season and the pyrethrin aerosols were found to be highly efficacious for control of chalcid parasitoids.

Chalkbrood (*A. aggregata*) occurrence was also evaluated in the 1999/2000 Saskatchewan winter survey. The disease was present at a low level (sporulating chalkbrood - 0.004% overall, sd 0.02, range 0.0-0.14%; non-sporulating chalkbrood - 0.007% overall, sd 0.04, range 0.0-0.30%); incidence of a related species (*A. larvis*) was significantly higher (0.40% overall, sd 1.01, range 0.0-7.28%).

The incidence of stored-product pests in Saskatchewan alfalfa leafcutting bee populations was once again evaluated through an extensive trap-nest survey undertaken during the 1999 field season. While a number of stored-product pest insect species have been identified in trap-nests during the past several years, species occurrence and level fluctuates widely from year to year. In the 1999 field season, the driedfruit moth, *Vitula edmandsae serratilineella*, and the black carpet beetle, *Attagenus unicolor*, were the only two stored product pest insect species observed in trap-nests. The stored-product pest which may pose the greatest potential threat to alfalfa leafcutting bee populations is the dried-fruit moth, since the larvae of this species damage polystyrene nest material and cells containing healthy bee larvae in their search for nectar and pollen in alfalfa leafcutting bee nests. Control of stored product pest insects in alfalfa leafcutting bee populations involves adequate breaking and tumbling of bee cells in the fall, and utilization of proper bee cell storage techniques during the winter.

**Continuing Research:**
Research to monitor parasitoid, predator, and disease levels in Saskatchewan alfalfa leafcutting bee populations, and to develop management strategies in these areas, is ongoing.

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**1. Title:** Evaluation of Egg Parasites for Biological Control of Bertha Armyworm

**Author and Associates:** Lorraine Braun, Peter Mason, Rob Bouchier

Problem: Bertha armyworm, *Mamestra configurata*, is a major pest of canola and mustard in western Canada. Control of the bertha armyworm has been primarily through foliar application of insecticides directed against feeding larvae. Increasing interest in biological and biorational approaches to insect control have led to consideration of use of egg parasitoids, particularly *Trichogramma* spp., as inundative biological control agents. In the second year of a three year study, the field performance of *T. inyoense*, *T. minutum* and *T. brassicae* was evaluated.

**Objective of Research:** To determine the distance *Trichogramma* wasps will disperse from a release point and to compare the performance (level of parasitism of bertha armyworm eggs) of *T. inyoense*, *T. minutum* and *T. brassicae*.

**Summary of Results:**  
Two field experiments were carried out on a privately owned canola field located close to Saskatoon. In experiment one, designed to measure distance traveled by parasitoid wasps to sentinel egg masses, *T. minutum* and *T. brassicae* successfully searched for and parasitized sentinel *Ephestia* eggs (up to 5 and 10 m from the point of release respectively). Emergence from the parasitized *Ephestia* eggs collected and reared in the laboratory exceeded 92%. The second experiment compared the performance of *T. brassicae*, *T. inyoense*, and *T. minutum* against sentinel *M. configurata* eggs. Only *T. brassicae* was successful at parasitizing bertha armyworm eggs (235 eggs parasitized at 1 m from the release point; 82% emergence).
Continuing Research:
The project will continue in 2001, with laboratory experiments designed to study the biology of the three species of *Trichogramma*, and field studies to determine the numbers required (dose) for application to maximize the number of host eggs parasitized in the field and to assess the consistency of performance of commercially supplied parasitoids.

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2. **Title:** Cruciferous Insect Pest Control

**Author and Associates:** J.J. Soroka, R. Elliott, O. Olfert, N. Zu, G. Rakow, and F. Katepa-Mupondwa, with funding from ADF

**Problem:** Flea beetles and root maggots continue to be economic pests of canola production on the prairies. This year damage to crops from both pests was generally higher than in recent years.

**Objectives of Research:**
Evaluation of crucifer germplasm for sources of resistance to crucifer root maggots and flea beetles
Biology of flea beetle response to phytochemicals
Development of a root damage - seed yield loss relationship for canola fed upon by root maggots

**Summary of Results:**
Laboratory bioassays were conducted at Saskatoon and field trials were conducted at Saskatoon and Melfort to evaluate crucifer germplasm for host plant resistance to flea beetles. Bioassays focused on lines of the species *Sinapis alba*, *Crambe abyssinica*, *C. hispanica hispanica*, *C. hispanica glabrata*, and *Camelina sativa*. Field trials evaluated lines of these species as well as *Brassica rapa*, *B. napus*, *B. carinata*, and *B. juncea*. Some of the factors evaluated included lines with high and low oil content, mucilage, erucic acid, glucosinolate level, and protein. Spring flea beetle feeding pressure was heavy. Post doctoral fellow Ning Zu developed an electroantennogram apparatus to test flea beetle response to volatile phytochemicals. Flea beetle EAGs to 25 commercially available volatile compounds were analysed using the system. A GC-EAD system was set up by coupling a gas chromatograph to the electroantennogram, and analytical parameters for this machine are under investigation.
Field trials were conducted to assess crucifer germplasm resistance to root maggots. Root maggot damage appeared to be greater this year than last. Roots remain to be rated. In a five species, five line trial conducted in 1998 and 1999, all five *S. alba* entries had the lowest root maggot feeding scores in both years, but the order of feeding damage among the other four species, *B. napus*, *B. rapa*, *B. juncea*, and *B. carinata*, was not consistent between years. Overall levels of maggot feeding were much lower in 1999 than in 1998, which may have affected species preference.
A cage trial to investigate economic injury levels of root maggots to *B. rapa* and *B. napus* canola was repeated, and roots remain to be rated. Preliminary indications are that feeding injury was heavy. However, this is the fourth year of the trial, and we have yet to see evidence of yield decline, at infestation...
levels as high as 100 root maggot eggs per plant, and root damage rating levels up to 4.0 on the Dosdall scale of 0 to 5. *B. napus* appears to be less affected than *B. rapa* by root injury.

**Continuing Research:**
Future investigations will examine crucifer lines and phytochemicals for susceptibility or resistance to crucifer pests, including laboratory and field bioassays for root maggots, flea beetles, and lygus bugs, concentrating on species with pest resistance such as *Sinapis, Crambe*, and *Camelina*.

Other research will investigate cultural methods of control of crucifer root maggots, including fertilizer treatments and the use of cover crops to decrease maggot injury, and to investigate the impact of fall tillage on pest insect population development in canola. Further investigations will be conducted to determine the relationship between root damage by maggots and canola seed yield losses.

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3. **Title:** Investigations on Forage Insect Pests

**Author and Associates:** J.J. Soroka, R. Venette, with funding from AFIF

**Problem:** Alfalfa seed producers are faced with numerous insect pests that threaten seed production. Economic thresholds are not known for the pea aphid, and producers do not know when or if control measures are warranted. The alfalfa blotch leafminer is a pest of hay alfalfa in eastern Canada that has recently been detected in Manitoba. Its presence in Saskatchewan has not been determined.

**Objectives of Research**  
To develop economic thresholds for pea aphid in prairie alfalfa seed fields, with the aim of incorporating aphid control into a program for integrated pest management in seed alfalfa.  
To determine if the alfalfa blotch leaf miner is present in Saskatchewan.

**Summary of Results:**  
Natural infestations of pea aphids were light for most of the season. This year a spray trial was added to the investigations. Seed yields have yet to be determined. In 1999, the levels of aphid infestation - light, medium, or heavy, had little effect on plant growth and seed yield, while timing of infestation - early July vs early August, did.  
A survey of alfalfa hay and seed fields in the eastern portion of the province for the presence of alfalfa blotch leaf miner was conducted in September of this year. No evidence of miner damage was found from samples from 30 locations. While this is good news, word from Minnesota is that 2000 was a very poor year for development of alfalfa blotch leaf miner populations, and the presence of the pest in Saskatchewan cannot be ruled out.

**Continuing Research:**  
Pea aphid economic thresholds will continue to be investigated. If large scale populations develop in producers’ fields, spray trials may be conducted.
Alfalfa blotch leaf miner presence across Manitoba and Saskatchewan will continue to be monitored. If it becomes common, the effect of its injury on alfalfa seed yields will have to be determined.

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4. **Title:** Evaluate sustainable cropping systems in relation to pest management and prairie agriculture

**Author and Associates:** Owen Olfert and Murray Braun

**Problem:** Profitability and soil degradation are major issues facing farmers in the grassland ecozone of the Canadian Prairies. Producers are encouraged to diversify away from cereal monoculture and to reduce fallow and inputs to address these issues. However, climatic and economic considerations do restrict what can be grown. This study was initiated to monitor and assess alternate input and cropping strategies with respect to (i) biodiversity (ii) pest dynamics (iii) farm profitability (iv) soil quality (v) food safety

**Objective of Research:** Quantify population density and biodiversity of soil arthropods in relation to long-term rotations.

**Summary of Results:** The experimental framework of nine different cropping systems is based on a matrix of three levels of input use, and three levels of cropping diversity. Evaluations are done on an annual or cyclical basis (6 year), to determine rate and direction of change over time. The design, data collection and evaluation are based on the collaborative efforts of crop, pest, economic and soil scientists. Soil arthropods are a major component of the evaluation. In addition to the nine cropping systems, the diversity of arthropods was evaluated in native prairie, in a 50-year old grass ecosystem and in grassy field margins. A baseline data set containing density and diversity of arthropods found in and on the soil has been compiled; the effect of long-term rotations and farming systems on arthropods is being evaluated. The anticipated outcome is: (i) to provide guidance for development of systems that maintain food quality and quantity, without increasing inputs of non-renewable resources; and (ii) to develop biological indicators which reflect the status of such systems.

**Continuing Research:** The research, which began in 1994 is expected to continue for 2-3 cycles of a six-year rotation (2006 - 2012)

5. **Title:** Chemical Pheromone for Management of Orange Wheat Blossom Midge (*Sitodiplosis mosellana*)

**Author and Associates:** Owen Olfert, Lori-Ann Kaminski, Gerhard Gries, Bob Lamb, John Gavloski, Jim Broatch, Janet Knoedel.

**Problem:** Wheat midge is an insect pest causing serious economic losses for wheat producers in Western Canada. According to present knowledge, the primary means of control of wheat midge infestations is the use of chemical insecticides. To determine if chemical control is required
producers are asked to estimate the number of wheat midge ovipositing on wheat heads between the hours of 20:30 and 22:30 during the period of time when the wheat is susceptible. The pheromone of wheat midge has been successfully extracted, isolated and identified. The plan in 2000 was to develop protocols and validate their appropriateness in the field. This step is considered essential to the future development of an effective pheromone-based monitoring of the orange wheat blossom midge.

**Objective of Research:** The 2000 objectives are:
1.) To determine the optimal dispenser type for a pheromone lure
2.) To determine the optimal trap design
3.) To determine optimal trap placement within the crop canopy

**Summary of Results:** A collaborative effort between the chemical ecology group at Simon Fraser University (Gries et al.) and AAFC-Saskatoon began in 1996. AAFC developed methods for harvesting and preserving wheat midge larvae in large numbers to facilitate pheromone extraction and bioassay research. SFU successfully extracted and identified a chemical compound from calling midge females in the laboratory (SFU) with adult midge supplied by AAFC and from field populations (Saskatchewan). Protocols were developed by AAFC for field testing the pheromone extracts, including trap placement, trap type, and trap height. Field trials were successfully conducted in SK, MB and ND in 2000.

**Continuing Research:** The research, which began in 1996, is expected to continue for a few more years to quantify the pheromone catch with population density.

6. **Title:** Lygus Plant Bugs

**Author and Associates:** D. Hegedus, M. Erlandson, L. Braun, J. Soroka, P. Mason

**Problem:**
Recently Lygus has been a problem in canola with 1.4 M acres being sprayed in Alberta in 1998. In 1998 a collaborative project funded by the Canola Agronomic Research Program (CARP), entitled “Identification of Pest Populations of Lygus spp. and Their Parasites in Canola”, was initiated to identify Lygus species and their parasites using molecular marker techniques.

**Objective of Research:**
This project was initiated: 1) to examine the genetic composition of populations of *L. lineolaris* and *L. borealis* attacking different canola varieties in western Canada and develop unique molecular markers for these populations; 2) to develop unique molecular markers for species of *Peristenus* parasites attacking *Lygus* species; 3) to develop a protocol (technology) that can be used by non-specialists for documenting molecular patterns; 4) to develop a diagnostic key based on molecular characters for use by non-specialists to identify populations of *L. lineolaris* and *L. borealis*; and 5) to develop a diagnostic key based on molecular characters for use by non specialists to identify immature stages of *Peristenus* species.

**Summary of Results:**
Field collections of overwintering and summer adults of *Lygus lineolaris* and *L. borealis* were made at six sites in Saskatchewan beginning in mid-April and proceeding through August, in 1998 and 1999. A summary of results was presented last year. Dissection of field-collected *Lygus* spp. nymphs was undertaken to determine the level of the parasite *Peristenus pallipes*. Data from both years indicate
parasitism levels in alfalfa were high (up to 70%), while *Lygus* nymphs collected from canola fields immediately adjacent to the alfalfa exhibited very low rates of parasitism (less than 5%).

Molecular techniques were used to design PCR primers that can be used to distinguish *L. borealis* and *L. lineolaris* nymphs. Sequence data obtained from *Peristenus* spp. allowed us to develop a similar PCR technology to detect parasitism of lygus nymphs. Initial tests of the procedure using samples from 1998 indicate that we are able to identify *Lygus* nymphs and *Peristenus* parasites to species level. With nymphs containing parasites at larval instar stage 2 or more mature we have been able to make accurate diagnoses of parasitism in 100% of cases. With nymphs containing only parasite eggs or 1st instar larvae the PCR test provides an accurate assessment of parasitism in at least 70% of cases. In these nymphs smaller amounts of parasite tissue relative to the host likely contribute to the slightly reduced sensitivity. Results to date indicate that for the Saskatchewan sites sampled, both *L. borealis* and *L. lineolaris* nymphs are parasitized by *Peristenus* and the parasite populations is made up exclusively of one species, *P. pallipes*. In addition, the initial population peak of *L. borealis* nymphs occurs somewhat earlier in the season than for *L. lineolaris* and corresponds with the appearance of the parasite and subsequently much higher rates of parasitism in *L. borealis*. Thus an important research and diagnostic tool has been developed that will lead to more precise analysis of Lygus population dynamics in various crops, as well as, the status of potential biocontrol by *Peristenus* spp.

**Continuing Research:** The goals for the final year of the project will be to confirm that PCR primers designed to distinguish the *Lygus* species are workable with DNA extracted from single *Lygus* nymphs. A simplified DNA extraction process will then be developed to expedite the development of a PCR kit for rapid identification of *Lygus* nymphs.

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7. **Title:** Potential host plant resistance to bertha armyworm, *Mamestra configurata*, among Brassicaceous species and cultivars

**Authors and Associates:** M. Erlandson, B. Ulmer, and C. Gillott

**Problem:** Bertha armyworm, *Mamestra configurata*, is a major pest of canola and mustard in western Canada, and its major economic impact is caused by larvae feeding on developing seed pods, significantly lowering seed yield and quality. Control of the bertha armyworm has been primarily through foliar application of insecticides directed against feeding larvae. However there is an increasing interest assessing possible sources of host plant resistance to insect pests of canola quality crucifer crops. Potential sources of resistance may then be useful to plant breeders in development of cultivars or at the very least give an early warning of significant susceptibility to pest insect damage. In 1997 a three year AFIF grant from Saskatchewan Agriculture and Food was obtained to support this research project.

**Objective of Research:** This project was initiated to: 1) examine bertha armyworm larval feeding preferences on a number plant lines from 5 Brassicaceous species in choice and non-choice assays;
2) determine the suitability of these plant lines for the growth and development of bertha larvae; and 3) to determine if there are varietal preferences for oviposition by bertha armyworm.

**Summary of Results:** Results of the choice and no-choice preference assays indicate that plant lines in the *B. juncea* and *S. alba* species are least preferred by bertha armyworm larvae. These same lines produced the lowest development rates and larval weight gains for BAW larvae. Foliar glucosinolates were measured for all plant tissues in the experiment. The data indicates that foliar sinigrin and sinalbin provide brassicaceous crops with some protection against larval feeding and indeed these compounds may have some toxicity for bertha larvae. Results from the oviposition trials indicate that there are only minor differences in attractiveness of the brassicaceous varieties tested with *B. juncea* being the least preferred. Laboratory and field studies to determine the attractiveness of various developmental stages of canola plants for oviposition showed that plants in full bloom were most attractive and that by the pod development stage plants are much less attractive for oviposition.

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Wheat seedlings were exposed to each of the three aphid species for six days and biomass gain by aphids and biomass loss by plants was recorded. In the field, aphids were placed on wheat in sleeve cages (single plants) and 1 m² cages (multiple plants). After feeding for three weeks, half of the replicates were assessed for aphid biomass gain and plant biomass loss. The other half were sprayed with an insecticide and the plants allowed to mature.

Interactions between aphids and wheat differed among aphid species and between the two growth stages tested. On seedling plants, *R. padi* exhibited the highest population growth, while on adult plants, *S. avenae* and *S. graminum* populations grew the most and had the greatest impact on yield. All cultivar-aphid combinations resulted in a reduction in plant biomass and seed yield compared to controls. No differences occurred among clones within aphid species or among cultivars within wheat classes. The CPS class of wheat suffered the greatest effects on yield production from aphid infestation, while CWAD was affected the least. The specific impact of aphids on wheat, i.e. the ratio of plant biomass loss to aphid biomass gain, ranged from 1.0 to 3.5 for seedlings and from 3.3 to 20.7 for adult plants. Thus, individual clonal effects may have no biological or ecological significance to the dynamics of aphid species. The study shows that cultivars within a class of wheat have similar susceptibility to aphids. On a weight for weight basis, young plants are more tolerant to aphid damage than mature plants. Susceptibility to aphids in young plants cannot be used to predict adult plant susceptibility because aphid-plant interaction between the two growth stages differ. Funding for this project has been provided by the Cereal Research Centre, Dow AgroSciences Canada Inc., and the University of Manitoba.

2) **Title:** Host plant relationships with the genus *Triticum* and the consequences of domestication for susceptibility of wheats to wheat midge - I.L. Wise, R. J. Lamb, M. Smith, Cereal Research Centre, Agriculture and AgriFood Canada, Winnipeg

The relative susceptibility to wheat midge of all species in the genus *Triticum* was accessed. The five lineages within genus all showed increasing susceptibility in the early phase of domestication mostly associated with changes in head morphology associated with ease of threshing. One accession which was free-threshing showed low susceptibility and may be a useful source of resistance. Host relationships within the genera *Secale*, *Hordeum* and *Avena* are now being investigated. Within *Hordeum*, of particular interest is what effect the development of hullessness will have on barley susceptibility to the wheat midge. Future research studies will focus on the host plant relationship of the wheat midge in other genera of the subtribe Triticinae, in particular species originating from Eurasia, the likely site of wheat midge evolution.

3) **Title:** Development of spring wheats with resistance to the wheat midge - R. H. McKenzie, R. J. Lamb, I. L. Wise, and P. S. Barker, Cereal Research Centre

Resistance to wheat midge has now been incorporated in advanced breeding lines of CPS, CWRS and CWERS classes of hexaploid wheat. The resistance is holding up well in multi-location field trials and the breeding process continues. High-yielding resistant wheat lines were included in the pre-registration trials in 2000 and may be ready for registration in 2001 or 2002.

4) **Title:** Development of durum wheats with resistance to the wheat midge - R. J. Lamb, J. Clarke, J. Thomas, R. H. McKenzie, M. Smith, I. L. Wise, and P. Clarke, Cereal Research Centre
We have now been successful at identifying a durum wheat with oviposition deterrence to the wheat midge, which reduces oviposition by 70-80% in choice and no-choice lab tests and in field trials. This durum wheat is being crossed with advance breeding lines to transfer the resistance to a line with the appropriate agronomic and quality traits for western Canada. We have now successfully transferred antibiotic resistance from our spring hexaploid lines to tetraploid durum. After further backcrossing we plan to include this resistance in the durum wheat breeding program, giving us a second possible resistance mechanism for durum wheat. The backcrossing and selection process continued in 2000 and will continue in 2001.

5) Title: Sticky trap monitoring of wheat midge as a sampling tool to determine the need to apply control measures - R.J. Lamb and I.L. Wise, Cereal Research Centre, J. Gavloski, Manitoba Agriculture

A sticky trap monitoring method for wheat midge adults in commercial fields was developed. The method uses ten sticky traps that are placed in wheat fields at the onset of heading and are kept in the fields for 3 days. The are then collected and midge adults are counted for comparison with a threshold based on the relationship between yield loss and adult catch. The traps proved accurate at identifying fields with low densities of wheat midge which do not require control, and therefore should eliminate unnecessary insecticide applications. The method was less accurate at or just above the threshold, but still provided a greater accuracy of prediction of yield loss than any other method that has been proposed.

6) Title: Biomass conversion in spring, durum and diploid wheats damaged by the wheat midge and a means of determining yield losses by the wheat midge in commercial wheat samples - R.J. Lamb, I.L. Wise, and J. Tucker, Cereal Research Centre.

Yield losses caused by the wheat midge in wheat fields were related to larval infestation levels based on the biomass conversion relationships between the insect and plant, and the consequences of insect feeding on seed biomass which affects whether damaged seed are retained during harvest. This information was used to develop economic thresholds for larval infestations in bread and pasta wheats of various grades.

7) Title: Protecting resistance genes in wheat and parasitoid populations when crop resistance to the wheat midge is implemented - M. Smith, R. J. Lamb, I. L. Wise, Cereal Research Centre, and O. Olfert, Saskatoon Research Centre.

Wheats with a high level of antibiotic resistance to wheat midge are now being developed. When released for commercial use mortality of wheat midge larvae in fields using these wheats will exceed 95%, putting a substantial selection pressure on the wheat midge and causing a comparable reduction in parasitoid populations. In 2000 we investigated mixed seeded plots with various proportions of resistant and susceptible wheats to identify a suitable mix which will minimize crop damage and maximize the survival of avirulent wheat midge and parasitoids. These large plot studies will be repeated in 2001, and research on the mating system and dispersal of wheat midge will be conducted. Computer models will be developed and used to help identify a refugia strategy to help preserve the resistance gene and to integrate biocontrol and crop resistance of wheat midge in spring wheat.
8) **Title:** Resistance to hessian fly in spring wheats - F. Townley-Smith, R. J. Lamb, I.L. Wise, Cereal Research Centre, and J. Whistlecraft, AAFC, London, Ontario.

Damage by hessian fly is intermittently reported from most of western Canada. The growing of resistant wheat has been a well established control strategy for this pest in the USA for many years. In 1997 we began a project to help wheat breeders incorporate the appropriate resistance genes into spring wheats for western Canada. Advanced breeding lines were screened for resistance both in the laboratory and in the field in 2000 and were found to have a useful, high level of resistance. If any of these breeding lines meet quality and agronomic requirements they will be registered, with Hessian fly resistance as an additional benefit to future cultivars, and be used to develop cultivars with both Hessain fly and wheat midge resistance.

9) **Title:** Effects of cereal crop rotations on insect populations - N.J. Holliday, Dept of Entomology, M. Entz, Plant Science, University of Manitoba

This is a long term project, in which carabid beetles and other insects are being sampled in cereal-legume rotations. Additional treatments are the addition of pesticides (mostly herbicides) and fertilizers in each rotation system. In the first eight years of the study, it is evident that complex crop architecture and persistence of crops for more than one year enhances the number of carabids and their species richness; however, these effects do not carry over into subsequent crops. Treatments without pesticides, particularly those with fertilizer, have higher levels of carabids, and this is apparently associated with high weed populations in these plots.

**RESEARCH ON DICOT CROPS**

1) **Title:** Management of root maggots on oilseed rape in Manitoba - N.J. Holliday, Dept. of Entomology, R. Scarth, Plant Science, University of Manitoba

This project started in 1999 with an examination of the effects of agronomic practices on the population biology of root maggots in canola and the damage to plants. We are currently examining the influence of tillage practices and seeding rates, on maggot populations, parasitism rates and predator occurrence. We are also examining the spatial distribution of root maggots within large field plots and commercial fields, and have found evidence for elevated incidence of maggots and damage at field margins. Beginning during winter 2000-01 we will examine the activity of Bacillus thuringiensis strains against cabbage maggots.

2) **Title:** Classical biological control of root maggots in canola - N.J. Holliday, Dept of Entomology, University of Manitoba, J. Soroka, Saskatoon and P. Mason, Ottawa, Agriculture and Agri-Food Canada, and U. Kuhlmann, CABI Bioscience, Switzerland.

In 2000, we began a three year project to assess the potential for introducing European parasitoids for control of root maggots (particularly Delia radicum) in canola in Canada. In summer 2000, weekly collections of immature Delia were made from canola at two sites in Alberta, one site in Saskatchewan and two sites in Manitoba. In fall, these collections were supplemented by mass pupal collections in the three provinces. As a result, we are rearing about 12000 Delia to define the parasitoid guild in canola in western Canada. This phase of the project will be completed in spring 2001, and will be followed by a similar program of assessment of the parasitoid guild of Delia in European brassicas beginning in in summer 2001.
3) Title: Development of an integrated pest management scheme for seed alfalfa: population processes - N.J. Holliday, P. MacKay, Dept. of Entomology, University of Manitoba

We are examining the populations of pests and beneficial insects in seed alfalfa and in alfalfa for hay, and are investigating how these are related to current production practices. We are also examining in detail the rates of pest colonization of seed fields sprayed with insecticides, and the role of predators in the dynamics of the major pests. In summer 2000, a large scale trial was conducted to determine whether natural enemies can be attracted from cut alfalfa hay fields to adjacent seed fields using aphid sex attractant pheromones.

4) Title: Biological control of bertha armyworm - N.J. Holliday, Dept of Entomology, University of Manitoba, P. Mason, Agriculture and Agri-Food Canada, Ottawa, and U. Kuhlmann, CABI Bioscience, Switzerland

We are just completing a project on European parasitoids of Mamestra brassicae that may be suitable for introduction in North America for control of the bertha armyworm, M. configurata. Data collected in Europe include information on the stage of host preferred and the response to host density of Microplitis mediator, as well as temporal and spatial distribution of host and parasitoids. Analyses performed to date suggest that M. mediator has quite specific host stage requirements for successful larval development, but that ovipositing female parasitoids often do not discriminate between suitable and unsuitable host stages; furthermore, daily oviposition rates by parasitoid females are relatively low. These features of M. mediator biology may explain why this species has not successfully established in M. configurata populations in western Canada.

5) Title: Integration of disease and insect pest management in potatoes - N.J. Holliday, Dept of Entomology, L. Lamari, Plant Science, University of Manitoba

We are investigating in the laboratory whether the elevated levels of foliar glycoalkaloids associated with feeding on potatoes by Colorado potato beetles confer enhanced defence against infection by fungal diseases such as late blight.

6) Title: Viruses in Manitoba Potato Fields in 2000 - D. McLaren, Crop Production Pathologist, Brandon Research Centre, Agriculture and Agri-Food Canada

The potato virology project was initiated in 1998 and is a collaborative study involving Agriculture and Agri-Food Canada, Manitoba Agriculture and Food, the Manitoba Crop Diversification Centre, a number of industry partners, and a number of commercial and seed potato growers. In 2000, 35 potato fields were surveyed for potato leaf roll virus (PLRV) and potato virus Y (PVY). This survey included a visual assessment of both commercial and seed potato fields. Evaluation of tubers for virus content will be conducted in the coming months. Fields were located in a number of areas including Shilo, Portage, Winkler, Holland, Carberry, Carman and Minto.

An aphid trapping network was also established to assess aphid movement and virus content in both commercial and seed fields. A total of 44 traps were distributed over 10 locations for approximately 10 sampling interval end dates. Both green pan traps and suction traps were operated in most fields. Aphids were collected from pan and suction traps and from leaf samples. Green peach, potato and buckthorn aphid identification was conducted from samples collected from all traps and leaves. Aphid samples and tubers (200 per field) will be assessed for virus content in the near future.
research will continue next year with the evaluation of both seed and commercial fields for PLRV and PVY and the establishment, and hopefully, expansion of the aphid trapping network within Manitoba potato fields.

HONEY BEE RESEARCH

1) Title: Winter fumigation of Varroa-infested honey bee colonies as a practical control alternative - R. Currie, Dept. of Entomology, University of Manitoba

Current control methods against Varroa jacobsoni, an introduced ectoparasitic mite of adult and immature honey bees, are failing because of resistance to miticides. Formic acid is a control alternative that is inexpensive and easy to use, but it can be labor-intensive, dangerous, and its efficacy varies under outdoor conditions. This study examined the use of formic acid on indoor-wintered colonies that were stored in darkness at 5 C for 4 months during 1999 to 2000. After 2 months in storage, colonies were placed in small rooms and fumigated with formic acid at various rates for 48 hrs. Fumigation reduced mite populations with higher rates increasing mite mortality without any increase in bee mortality. Repeated fumigation periods may increase efficacy of this treatment and should be tested in the future.

STORED PRODUCT RESEARCH

1) Title: Mortality resulting from interactions between the red flour beetle and the rusty grain beetle - N.D.G. White, Cereal Research Centre, Winnipeg, S. Suresh, D.S. Jayas, and R.B. Hulasare, University of Manitoba

Tribolium castaneum and Cryptolestes ferrugineus occur together in bulk grain and we demonstrated high levels of cannibalism and predation by all mobile stages of both insects. At relatively high densities, the population of T. castaneum would probably be reduced in the long term because of cannibalism by the larvae and adults, and also because of predation, mainly by C. ferrugineus adults feeding on eggs and larvae. Cryptolestes ferrugineus larvae and pupae typically are protected from predation by developing under the seed coat that covers the germ of cereal seeds, and, thus, predation would be less than indicated by our study. This study confirms a casual earlier report by Lefkovitch that if T. castaneum and C. ferrugineus are reared together in wheat, the populations of T. castaneum may be reduced relative to controls that were without interspecific interactions.

2) Title: Comparison of two models of grain temperatures and insect populations in stored wheat - N.D.G. White, Cereal Research Centre, S. Mani, W.E. Muir, and D.S. Jayas, University of Manitoba, P.W. Flinn, USDA-ARS, Manhattan, Kansas

Grain temperatures and insect populations predicted by a hot spot model, which includes feedback from the insect model to the temperature model, and a spatial model, which does not include that feedback, were compared. The hot spot model predicted a maximum of 120 adults/kg of wheat at the centre of the grain bulk towards the end of fall and reached a maximum temperature of 39 C while the spatial model predicted an adult population of 500 adults/kg of wheat and no increases in temperatures for an initial grain temperature of 30 C, an initial Cryptolestes ferrugineus (rusty grain beetle) population of 10 000 adults, and Winnipeg, Canada storage conditions. For the same simulation conditions but using weather data for Topeka, Kansas the hot spot model predicted a
maximum of 150 adults/kg of wheat at the centre of the bulk in fall while the spatial model predicted a maximum of 800 adults/kg of wheat. Due to the warm ambient temperatures in Topeka, Kansas the insect populations predicted by both the hot spot and spatial models were higher and insect development was earlier than those predicted under Winnipeg storage conditions.

3) Title: Toxic action of the fumigant phosphine on adults of the grain mite *Tyrophagus putrescentiae* - N.D.G. White, Cereal Research Centre, F. Jian and D.S. Jayas, University of Manitoba

The inhibitory effects of phosphine gas on cytochrome C oxidase and catalase, both *in vivo* and *in vitro*, and gas uptake by adults of *Tyrophagus putrescentiae* were determined. The activities of both enzymes were reduced by the gas. Relative inhibition rates of the enzymes were: *in vivo* catalase > *in vitro* catalase, *in vivo* cytochrome C oxidase < *in vitro* cytochrome C oxidase, and the inhibition effects of *in vitro* enzymes were proportional to the exposure period of phosphine applied to the cytosolic extracts. Although the uptake of phosphine by adults increased with an increase of phosphine concentration and exposure period, the rate of uptake was relatively slower than at lower concentration and short exposure period. The absorption mechanism of phosphine between insects and mites appears to be different, with direct cuticular penetration in the mites.

4) Title: Detection of insect infestations in wheat kernels using soft X-rays - N.D.G. White, Cereal Research Centre, C. Karunakaran and D.S. Jayas, University of Manitoba

A soft X-ray technique using a fluoroscope, a CCD black and white camera, a monitor, an image digitizer, and a personal computer has a high potential to detect infestation in grain kernels at a faster rate than the existing methods. Existing methods include Berlese funnel extraction; probing and screening grain; and incubation of grain samples. More than 87% of CPSW, CWRS, and CWAD wheat kernels were correctly classified in these preliminary tests using SAS or a neural network. Infested kernels by different life stages of *Cryptolestes ferrugineus* were classified with more than 87% classification accuracy while the misclassification of sound kernels as being infested was less than 10%. The X-ray technique can also be used to detect whether insects inside the kernels such as *lesser grain borer* or *rice weevil*, are alive or dead. These observations can be used to determine whether the incoming grain to an elevator has been fumigated or needs to be fumigated. The main drawbacks to the technique are the initial capital cost of $90,000 and limited sample sizes.

5) Title: Laboratory and granary trials using pea protein to control stored-product insects - Xingwei Hou, Dept. of Entomology, University of Manitoba, and Paul Fields, Cereal Research Centre, Agriculture & Agri-Food Canada

A protein-rich pea flour obtained from Parrheim Foods Ltd. (Saskatoon, Canada) was toxic to stored-grain insects, reduced the second generation and was repellent. *Rice weevil* (*Sitophilus oryzae*) was the most sensitive insect, followed by *rusty grain beetle* (*Cryptolestes ferrugineus*) which was more susceptible than *red flour beetle* (*Tribolium castaneum*). Insects held on wheat and barley showed similar sensitivities to pea protein, whereas insects held on maize were less sensitive. Granary tests were conducted from late August until late October. Granaries were filled with approximately 10 t of barley and treated with 0.1% pea protein (entire grain bulk), 0.5% pea protein (top half only) or untreated (2 granaries/treatment). *Sitophilus oryzae*, *C. ferrugineus* and *T. castaneum* were placed on the top surface of the grain (ca. 2 adults of each species/kg barley). The barley was sampled for insects at 4 times during the 2-month test (10 one-kg samples/granary). Grain samples from the bin
were also incubated in the laboratory to estimate the number of offspring in the grain. *Sitophilus oryzae* was controlled at 0.1%, *C. ferrugineus* and *T. castaneum* were reduced at 0.1% pea protein. The treatment of 0.5% was similar to the 0.1% treatment in the treated half of the bin, but insects were able to reached the untreated grain. Pea protein also increased the movement of the three species tested, in both granary and laboratory trials.

6) **Title:** Canadian Grain Storage CD-ROM - Paul Fields and Noel White, Cereal Research Centre

The Storage Group at the Cereal Research Centre (Agriculture and Agri-Food Canada) the Department of Biosystems Engineering (University of Manitoba) and the Canadian Grain Commission have published a CD-ROM containing information on stored products. The CD will benefit farmers, elevator managers, researchers, students and others with an interest in the challenges of keeping stored grain safe from pests.

It includes:
I. Store: a program to assist in grain storage
II. Videos: monitoring pests in stored grain, stored-product insects and mites
III. Images: over 200 images of insects, moulds, storage structures
IV. Pesticide labels: insecticides and rodenticides used in farms and food processing facilities
V. Reference databases: approximately 20,000 references on stored products
VI. Phosphine Corrosion Calculator: program modeling copper corrosion by phosphine
VII. Publications: over 10 publications on stored grain protection

*Protection of farm-stored grains, oilseeds and pulses from insects, mites and moulds.*

*Beetles associated with stored products in Canada: An identification guide.*

*Official Grain Grading Guide* (Canadian Grain Commission).

*Grain Preservation Biosytems* (a text book for university level course).

and several publications on alternatives to methyl bromide fumigations.

A large part of this information will be also available on the AAFC CRC web site, [http://res2.agr.ca/winn/stored.htm](http://res2.agr.ca/winn/stored.htm).

**APPENDIX C: OTHER AGENCY REPORTS**

**Saskatchewan Aerial Applicators Association (SAAA) & Canadian Aerial Applicators Association (CAA)***

Lorin Rubbert, CAAA director & secretary/treasurer, Oxbow, SK

Members quickly adopt new spray technology and new airplane technologies. An estimated 75% of the members are using GPS technology. Modern ag pilots are highly trained professionals, with ongoing upgrading on safety, crop care products, technical and environmental concerns. Calibration Clinics are offered by the CAAA, to test and modify spray equipment and patterns, and assist in educating applicators in regard to drift management.

The SAAA in conjunction with SAF designed and implement the aerial applicator training program. This program is being adapted for use as a national training program.

The associations developed their own insurance program. CAIR (Canadian Applicators Insurance Reciprocal) continues to establish a successful & enviable track record. CAIR also sponsors an annual safety seminar with premium discounts for attendees.
Aerial application offers some unique advantages to modern farmers. The ability to apply crop protection products in a timely manner. Application of fungicides, herbicides, or insecticides quickly; even in wet conditions. Crop loss due to compaction is nonexistent, as are ruts or trampled straw.

Goals and Objectives

· To promote and foster the development of a professional approach and attitude to aerial application.
· To develop professional standards in the industry.
· To promote research and development in crop care products and application techniques.
· To protect the environment.
· To develop an effective liaison with government agencies.

SAAA website - http://www.webster.sk.ca/saaa/
CAAA website - http://www.CanadianAerialApplicators.com/

Pest Management Regulatory Agency – Najib Malik; Ottawa, ON
Ground Squirrel issues – PMRA has received many complaints that the currently register ready to use strychnine bait for ground squirrel control (0.4% strychnine) are more expensive and not as effective as the liquid concentrate formulations previously available. The PMRA is seeking advice from the western provinces (BC, AB, SK, and MB) regarding:
1) the scope of the ground squirrel problem in each province
2) the effectiveness of current pest management tools
3) the economics of the various options.
It is requested that each province provide the PMRA (c/o Dr. Martha Farkas) with the name of a contact person by Nov. 15, 2000.
Dr. Martha Farkas, PH: 613-7363772, EMAIL: martha_farkas@hc_sc.gc.ca
Eastern Cereal & Oilseeds Research Centre (ECORC) – Lorraine Braun presented for Peter Mason.

P. Mason, R. Footit, H. Goulet and M. Schwartz, AAFC, Ottawa
U. Kuhlmann, CABI Bioscience
H. White, University of Manitoba
B. Broadbent and J. Whistlecraft, AAFC, London
L. Braun, AAFC, Saskatoon

- In N.A., *P. pallipes* is probably a complex of at least 5 species, each of which is specific to a host species in one genus or to a few host species in genera of one tribe or region
- In Europe studies showed that *P. digoneutis* Loan is specific to the Mirids (species of *Adelphocoris*, e.g., *A. lineolatus*, and *Lygus* spp.), and *P. stygicus* Loan to *Lygus* spp., even in habitats where mirid plant bug diversity is high
- Surveys begun in 1997 in southern Quebec have confirmed the establishment of *P. digoneutis* in Canada. The distribution is presently restricted to regions south of the St. Lawrence River. *Lygus lineolaris* populations are heavily parasitized (up to 70% of 1st generation and 50% of 2nd generation N4 & N5 nymphs).
- Mass rearing of *Peristenus* spp. Is being done in London, ON.

Canadian Food Inspection Agency (CFIA)

Brian Rex, tel. – 204.983.2236, FAX – 204.983.8022
Winnipeg, MB

There was concern that some peach trees moved to Winnipeg may have had the plum pox virus. [http://www.cfia-acia.agr.ca/english/plaveg/hort/survey6e.shtml](http://www.cfia-acia.agr.ca/english/plaveg/hort/survey6e.shtml)

Cereal Leaf Beetle (CLB) *Oulema melanopus* (L.) – California is blocking the movement of hay and straw from areas known to have CLB. Shipments destined to California require a Phytosanitary Certificate stating that the source is a CLB free area. USDA is carrying out surveying and reporting of these areas through the APHIS program. See attached map. USA distribution map and information at: [http://ceris.purdue.edu/napis/pests/clb/index.html](http://ceris.purdue.edu/napis/pests/clb/index.html)
The CLB is known to occur in the provinces of Ontario and Quebec. Until 1999, it had not been reported in other Canadian provinces. [http://www.cfia-acia.agr.ca/english/ppc/science/pps/datasheets/oulmele.shtml](http://www.cfia-acia.agr.ca/english/ppc/science/pps/datasheets/oulmele.shtml)

In 1999 a cooperative CLB detection survey was conducted involving CFIA, BCMAFF and AAFRD. Crops surveyed included winter wheat, spring wheat, barley, oats and the headlands of the fields. A total of 105 fields were surveyed covering an area of 4360 ha (10,770 acres) in 14 counties. No CLB were found in AB. In BC the survey was limited to the Creston Valley. Cereal leaf beetle was detected by sweep netting in four of six fields surveyed, close to the US border. These included two spring wheat fields, one winter wheat field and one barley field. In the positive fields, little or no feeding damage was observed.

CFIA, BCMAFF, AAFRD, SAF and MAF conducted CLB Survey 2000.
- AB – 64 fields, 6,799 acres
- SK – 85 fields in an area from Val Marie east to the MB border, bounded on the north by Highway 18 and south to the US border.
- MB – 49 sites within the 4 townships north of the US border from the SK border east to Vita,
CFIA has added this insect to their list of annual surveys and will continue with a minimum of 100 fields in each of the 3 Prairie Provinces. There is currently a biological control program in Ontario. Idaho is participating but as yet the eastern egg parasitoid is not working in the western US.
Reported DISTRIBUTION of Cereal Leaf Beetle, Oulema melanopus

2000–10–20 Data retrieved from National Agricultural Pest Information System

The Center for Environmental and Regulatory Information Systems does not certify to the accuracy or completeness of this map.
APPENDIX D: SPECIAL REPORTS

1. Entomological Issues involving the biological control of noxious weeds – Garry Bowes (Coordinator, Noxious Weeds Management Program)

Biological Control of Scentless Chamomile
Funded by Saskatchewan Agriculture and Food, Saskatchewan Association of Rural Municipalities and the Agri-Food Innovation Fund

Objectives of this project under the noxious weeds control program are to:
1) set up new chamomile biocontrol sites
2) monitor existing biocontrol sites for chamomile and leafy spurge
3) develop an integrated control program
4) develop partnerships

Scentless chamomile can cause significant yield losses to spring wheat. Depending on weather during the growing season; scentless chamomile at a density of 25 plants per square meter can reduce spring wheat in farmers fields by up to 80%.

An integrated approach uses various methods of crop and road right of way weed control. Seed the crop right to the edge of the prepared seed bed. Pick, bag and burn small scentless chamomile patches. Use spot herbicide treatments and treat with herbicide along the gravel edge of a road. Mow early and not for use as hay if scentless chamomile is present. Encourage a healthy grass crop along the roadside; reseed or fertilize. Use biocontrol agents.

Biocontrol agents –
**Scentless Chamomile Seed Weevil** (*Omphalapion hookeri*) - Established in 1992 and moved 7 Km. In the following 7 years. In 1999 collection sites had between 46 – 95% seed heads infested. In 2000 very few plants at the collection sites. It is estimated that this weevil will destroy 40% of scentless chamomile seed.

**Scentless Chamomile Stem Weevil** (*Microplontus edentulus*) - Released in 1997 at one site, two years latter 62% damage to chamomile plants 100 metres from the original release. In 2000 this stem weevil was released at 2 sites with establishment at one.

**Scentless Chamomile Gall Midge** (*Rhopalomyia n. sp.*) – Released in 1999 at 5 sites and established at 4 of those. In 2000 the midge was released at 7 sites and became established at 5.


Small Grains Pests

**Orange Wheat Blossom Midge** – *Sitodiplosis moselana*
Low populations overall except for a few hot spots in the NW and NC parts of the state. A fall soil survey was carried out in 1999 to sample for overwintering wheat midge cocoons and a forecast map was posted to the NDSU web site at

**Cereal Aphids - English Grain Aphid, Bird Cherry Oat Aphid, Greenbug**  
Did not develop into a pest problem in 2000.

**Armyworm** – Were a localized problem in eastern North Dakota and north western Minnesota, infested maturing barley and wheat at 3 – 10 per sq ft.

**Cereal Leaf Beetle** - Is a new small grains pest for North Dakota. It was detected at very low levels in the Williams and Mackenzie Counties near the Yellowstone River. The whole state was surveyed. Distribution maps at http://ceris.purdue.edu/napis/pests/clb/index.html

**Canola Pests**

A Monitoring network for Canola Insect pests uses pheromone traps for **Diamondback Moth, Bertha armyworm** and sticky traps for **Flea beetles**  
http://www.ag.ndsu.nodak.edu/minot/pestsum/tablelink.htm

**Diamondback moth** populations were HIGHER in 2000 than 1999 cumulative trap counts were
- 1998 = 223 moths/site
- 1999 = 126 moths/site
- 2000 = 218 moths/site

**Bertha armyworm** were low and no treatments reported
- 1998 = 54 moths/site
- 1999 = 42 moths/site
- 2000 = 47 moths/site

**Flea beetle** populations were very high and damaging in many parts of the state

**Nutall’s Blister beetle** - found in canola fields in July but NOT damaging numbers.

**Green peach aphids** - found in late-planted canola fields but low numbers compared to 1999.

**Lygus bugs** - No problems in ND yet! Northern MN seeing increasing numbers

**Sunflower Insect Pests**

For North Dakota Extension bulletin #25 “Sunflower Pest Management”  
http://www.ext.nodak.edu/extpubs/plantsci/rowcrops/eb25w-6a.htm


**Weevils - Sunflower stem weevil** *(Cylindrocopturus adspersus* LeConte) - Only SW ND had Sunflower stem weevil complaints but larvae in stalk are difficult to find (Source: L. Charlet)
Black seed weevil -  *(Apion occidentale* Fall) - in Western ND there were increasing complaints about black seed weevil during seedling stage

Red Sunflower seed weevil -  *(Smicronyx fulvus* LeConte) - Reported throughout state in Oil Sunflower the majority of fields were NOT sprayed, an E.T. of was the same in 1999 and 2000 at 7-9 weevils per head. In Confection Sunflowers the majority of fields were sprayed an E.T. = 1 weevil per head was used.

Banded Sunflower Moth – *(Cochylis hospes* Walsingham) - Increasing levels from 1999 but not dramatic, North Central ND had localized infestations of between 5-10 larvae/head

Sunflower Midge – *(Contarinia schulzi* Gagne) – Larry Charlet USDA-ARS and Gary Brewer NDSU surveyed fields and produced a map showing high numbers in a localized area of the Red River Valley and moderate numbers in an area of south central ND.

**Corn Insect Pests**

European Corn Borer – Univoltine infestations are down, some minor larval infestations from the 2nd flight of bivoltine. In season growers can check updates by the *North Dakota State University ECB Moth Flight Tracking Project*  
http://www.ag.ndsu.nodak.edu/aginfo/entomology/entupdates/index.htm

**Dry Beans and Soybeans**

Potato Leafhopper – in 2000 there were fewer migrants that moved in later in the season so lower than 1999.

**General Insects**

Grasshoppers – populations began a decline in 1998 and continue quite low.

406.433.5038 (FAX)  
USDA – ARS  Northern Plains Agricultural Research Lab  
1500 North Central Avenue  
Sidney, Montana  59270  www.sidney.ars.usda.gov

The Northern Plains Agricultural Research Laboratory services a 9 state area including Montana, North Dakota, South Dakota, Nebraska, Kansas, Colorado, Utah, Wyoming and Alaska.

1) Crop, Soil & Water Management  
   a) Movement of agricultural chemicals in irrigated systems  
   b) Profitable alternative cropping systems  
   c) Precision agriculture  
   d) Management and its Effects on Soil Quality  
2) Ecologically Based Pest Management  
   a) Grasshopper management on the Great Plains and in Alaska
i) Develop sustainable grasshopper management systems that use grazing management and ecological processes (Changes in plant canopy, pathogens) in place of pesticides
ii) Decrease grasshopper outbreaks while maintaining or improving range condition
iii) Provide producers and land managers with a grasshopper integrated pest management CD in 2000
iv) Develop an integrated Alaskan grasshopper management program

b) Wheat Stem Sawfly Management
i) Enhance biological control
ii) Find and import biological control agents for wheat stem sawfly and other key pests
iii) Provide biological control information

c) Weed Control in Conservation Tillage Systems
i) Develop a systems approach to weed management problems
ii) Develop and evaluate the use of new, low-cost technologies for weed control
iii) Incorporate biological controls with various cultural practices in weed management systems
iv) Develop pest management decision aids

3) Biological Control of Weeds
   a) Classical biological control for selective invasive, exotic weeds
      i) Prioritization of noxious weeds to target for biological control see Invaders database at http://invader.dbs.umt.edu/Noxious_Weeds/
      ii) Target Weeds - Leafy Spurge - through The Ecological Area-wide Management of Leafy Spurge or TEAM Leafy Spurge. This is a broad coalition of federal and state government agencies, university researchers, ranchers and private landowners.
Spotted and Diffuse Knapweed, Field Bindweed, Mustard Family Weeds (dyer’s woad, hoary cress, perennial pepperweed
b) Mass –rearing and augmentation of arthropod and microbial biological control
   c) Impacts of introduced biological control agents on biodiversity and ecosystem dynamics

4. The Outbreak of Glassy Cutworm (Crymodes devastator) in Alberta 2000 - Lloyd Dosdall - AAFRD

Contributors: Bob Byers, Garry Coy, Kerry Clark, Hector Goudreau, Richard Guitard, John Huffman, Jennifer Otani, Hugh Philip, Dale Seward, Julie Soroka, Duane Stevenson, Calvin Yoder

Chronology of Events
- May 2000, Dale Seward (Crop Specialist, Fairview) investigates ‘winter kill’ in fescue, and reports 3 to 4 cutworm larvae per tuft; most larvae are in the plant crown or just below.
- Size ranges of larvae varied considerably, from about 1 to 3 cm in length.
- As word of the cutworm outbreak spreads, virtually all grass seed crops throughout the Peace River region are found to be infested with cutworms to some degree
- Larval specimens forwarded to Jennifer Otani are identified tentatively as the glassy cutworm
- Dale Seward holds a ‘cutworm vigil’ in a fescue field near Fairview and participants determine that around 11:00 pm some larvae were moving above ground to feed
- Spray trials are begun at once with Lorsban; Specialists estimate that efficacy was ca. 30%
- Most insecticide applications were with Lorsban 4E at 0.5 L per acre in 20 gallons of water, for a total cost of $12.00 per acre. Some applicators charged an additional $5.00 per acre for the 20 gallons of water.
Bob Byers recommended Decis because of high efficacy of synthetic pyrethroids against noctuids.

Aventis recommended Decis 5EC with 10 gal./acre of water, for residual activity against cutworms for 5 days.

Best results were achieved by those farmers who sprayed just before or during rain.

Species composition - Using reared specimens, R. Byers identified most adults as glassy cutworm, Crymodes devastator. Some specimens of yellow-headed cutworm, Apamea amputatrix, and two Agroperina species were also confirmed.

Crop Damage - included; crop thinning, destruction of fibrous root tissue and death of top growth. Crop damage was concentrated on 'chaff rows' that is places in the fields where vegetative matter had been cut and left to dry in the preceding fall. Damage was also most severe in areas surrounding power poles in fescue fields. Crop recovery was evident soon after the onset of spring rains, but at harvest yields were still depressed. The area that sustained the worst damage also had the lowest rainfall; between 35 – 65% of total long-term normal rainfall for the summer.

Crop Recovery - The return of normal precipitation throughout the Peace River region enabled many crops to recover later in the season.

Natural Enemies - Birds, especially gulls, were often observed feeding on glassy cutworm larvae. At least three parasitoid species were reared from glassy cutworm larvae, most notably a polyembryonic encyrtid species. In late August, many braconid pupal cocoons were evident in grass tufts in infested pastures. Some cutworm pupae were parasitized; others were infected by pathogens.

Host Crops - Tall red fescue, creeping red fescue, and timothy were most susceptible to infestation by glassy cutworm. Bluegrass was also susceptible, but comprised very few acres.

Insecticide Spray Trial - D. Seward, Crop Specialist, Fairview
Spray #1 = $12.00 per acre; 30% cutworm mortality
Spray #2 = $12.00 per acre; 95% cutworm mortality
15-acre Check Strip left untreated
Economic analysis
Sprayed Area = 843 pounds of seed per acre
Check Strip = 729 pounds of seed per acre
Yield Difference = 114 pounds per acre or $114.00 per acre at $1.00 per pound
Economic Returns from Insecticide Applications: $90.00 per acre

Crop Loss Estimates - in total, approximately 68,000 acres in the Peace region were infested with glassy cutworm complex. With about half pasture and half seed crops, estimated crops losses were $495,700.00 on pasture and $4,462,500.00 to cropland.

Extension Activities - A series of extension meetings, organized by Jennifer Otani and John Huffman, were held at several Peace region locations with Dr. Bob Byers providing expertise. Alberta Agriculture Crop Specialists conducted many extension activities, especially interviews with the press and individual field assessments.
Cutworm populations into fall 2000 – relatively abundant in some fields overwintering as 2nd and 3rd instar larvae.

Summary:
1. Although several cutworm species were implicated in the outbreak, most damage was caused by the glassy cutworm, *Crymodes devastator*.
2. Crop losses were most severe to seed crops, but pastures were also damaged. Densities of 25 larvae per 20-cm-diameter clump were common. Conservative estimates of economic losses were 0.5 million dollars to pastures and 4.5 million dollars to seed crops.
3. Insecticide applications were effective for reducing crop losses. Greatest efficacy was achieved by spraying before or during rainfall to enable carry of active ingredients below the soil surface. Both Lorsban and Matador were effective.
4. Parasitism was evident, but it is not yet known whether parasitism levels are sufficiently high to prevent a similar outbreak in 2001. Observations in fall of 2000 indicate high larval numbers in some fescue fields.
5. The region of Alberta most severely infested by glassy cutworm closely paralleled the area affected by drought in 1998 and 1999. Return of normal precipitation to the area may signal reduction in pest populations.

5. Ecological Risk Assessment of transgenic Crops – Insect Resistance
Lorraine Braun, AAFC, Saskatoon Research Centre

Background - Food safety of Biotech plants
Hazard identification and risk assessment
· Potential for toxicity
· Potential for allergenicity
· Safety of antibiotic resistant marker
· Retention of nutritional value
· Equivalence of composition
· Unintended effects

Gene flow can be neutral. There is always a certain amount of natural variation in populations. Levels of neutral variation in a wild population will decrease under gene flow from a domesticated relative. Detrimental gene flow means that disadvantageous alleles can counteract local selection and reduce local fitness.

Beneficial gene flow accelerates the frequency of favorable alleles in a sink population. Negative gene flow can cause 1) evolution toward increased weediness, 2) the increased likelihood of extinction of wild relatives. Crop to weed gene flow has been implicated in 7 important world crops; wheat, rice, soybean, sorghum, millet, beans, sunflower seed.

Gene flow cannot occur without hybridization.
· Cross-pollination must occur
· Both Taxa must be in flower at the same time
· Plants must be close enough in space for the vector to carry pollen between them
· Plants must be cross-compatible so the pollen is able to germinate and effect fertilization
· If resulting embryos develop into viable seeds and germinate there can be variable fitness of the resultant F₁ generation.
· The frequency of fertile hybrids affects the chance of introgression.
Canola—Chevre et al 1997—documented introgression of glucoinate ammonium resistance from *B. napus* to wild radish *R. raphanistrum* under experimental conditions.

Novel traits in *B. napus/B. rapa*

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<td>Glufosinate-ammonium resistance</td>
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<td>Glyphosate resistance</td>
<td>Roundup-Ready™ gene</td>
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Novel traits in *B. napus/B. rapa*

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<td>Turnip yellow mosaic virus resistance</td>
<td>non-coding regions of TYMV genomic RNA resistance to</td>
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<td>fungal infection</td>
<td>chitinase</td>
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<td>Insect resistance</td>
<td><em>Bacillus thuringiensis</em> CrylAc</td>
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A multi agency study was begun in April 1, 1999 and will run for 3 years. **Ecological risk of transgenic insect (Bt) resistance under Canadian Field conditions, gene flow to two weedy relatives of canola (wild radish and wild rape) and ecological risk assessment of diamondback moth to Bt transgenes.**

AAFC - S. WARWICK, P. MASON, L. BRAUN AND A. LEGERE
EC – S. Lesage and J. Lawrence
CFIA - S. Yarrow
USDA - N. Stewart

To investigate the movement of insecticidal and “in vivo marker” transgenes from canola (*Brassica napus*) into two closely related weeds via hybridization, introgression and to examine the ecological risk effects of insect resistance to such transgenes under Canadian field conditions.

The study will follow the Bt gene (synthetic truncated *Bacillus thuringensis* cry1Ac) using a selectable marker (neomycin phosphotransferase nptII from Escherichia coli) and a visible marker (modified green fluorescence protein, BT-GFP).

Year 1: Field plots were set out in 2 locations, Saskatoon and Ottawa. Artificial insect pressure was applied in cages to transgenic *B. napus* with BT-GFP. The diamondback populations were field collected in Saskatchewan in 1998 then reared in the lab and screened using a leaf disk bioassay for resistance to Bt endotoxins.

Year 2: Simulated gene flow by planting 1 *B. rapa* plant in the middle of 600 *B. napus* plants all in 12 m² blocks.

**APPENDIX E: ATTENDANCE/CONTACTS**
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<tr>
<th>Name</th>
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