PLANT BUGS (HEMIPTERA: MIRIDAE) ON BUCKWHEAT AND SEED ALFALFA CROPS IN MANITOBA: DYNAMICS, YIELD IMPLICATIONS AND MANAGEMENT

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Ayman Mahmoud Mostafa

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ABSTRACT

Ayman M. Mostafa. The University of Manitoba, 2007. Plant bugs (Hemiptera: Miridae) on buckwheat and seed alfalfa crops in Manitoba: dynamics, yield implications and management.

Supervisor: Dr. Neil J. Holliday

The assemblages of plant bugs in buckwheat and seed alfalfa in southern Manitoba mainly include the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), and the alfalfa plant bug *Adelphocoris* spp. While the most abundant species of mirid plant bugs in buckwheat is *L. lineolaris*, this species and *Adelphocoris* spp. are about equally common in both organic and conventional fields of seed alfalfa. *Lygus lineolaris* has two generations in both crops in all the study locations. Lygus bug adults can move from drying swaths of canola near buckwheat and seed alfalfa late in the growing season. However, it seems that canola is not the only source of migrated lygus bugs late in the growing season. Low temperature and precipitation are likely to reduce the ability of migrating insects to move into the crops in late summer.

Caged buckwheat experiments showed that buckwheat yields were reduced mainly as a result of feeding of *L. lineolaris* nymphs at flowering stage. Insecticidal manipulation of insect populations confirmed this finding, and indicated that the nymphal population was synchronized with the flowering stage of the plant, mainly during August. In field insecticide trials, control that reduced nymphal populations at the flowering stage provided yields 12 – 78% greater than in unprotected controls. *Beauveria bassiana* applied against adults in September produced a significant fungal infection in bugs, although the number of bugs in treated and control plots did not

differ. The gain in yield as a result of this application was inconsistent. Similarly, conventional insecticide application in early September did not consistently provide significant yield benefits.

Over three years, controlling the plant bug population in seed alfalfa crops late in August and September did not result in greater yield quantity or quality than in untreated controls. This lack of yield response occurred despite the insecticide application effectively controlling the plant bug populations.

Dedication

To my mother and father, who gave me a love of life
To my wife, who gave me a life of love
To A'ser and Rohayma, who gave joy and meaning to it all
And
To the memory of my grandparents, whose wisdom lightens the pathway of my life

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CHAPTER I

General Introduction

Introduction

Buckwheat, *Fagopyrum esculentum* Moech., a food crop, and alfalfa, *Medicago sativa* Linnaeus, a forage crop, are well established crops in Manitoba. There are many differences between the two plants; alfalfa is primarily grown as a feed for livestock and is a perennial plant with seeds enclosed in pods (Goplen et al. 1987), whereas buckwheat is a human food and an annual plant with exposed flowers and seeds (Manitoba Buckwheat Growers Association 1998). Despite the differences between the two crops, alfalfa (Goplen et al. 1987; Soroka 1991; Harris 1992; Schaber 1992; Uddin 2005) and buckwheat (Elliott and Wise 2002; Wise et al. 2005) are commonly associated with the plant bugs in the family Miridae, order Hemiptera.

Plant bugs (Hemiptera: Miridae) have been reported attacking alfalfa crops throughout the world (Sedivy 1972; Sedivy and Kodys 1972; Holopainen and Varis 1991; Hori and Kishino 1992; Varis 1995), in North America (Shull et al. 1934; Hughes 1943; Jeppson and MacLeod 1946; Radcliffe and Barnes 1970; Gupta et al. 1980; Walstrom 1983), in Canada (Craig 1961; Craig 1963; Craig 1971; Schaber and Richards 1979; Smith and Ellis 1983; Murrell 1987; Harris 1992; Schaber 1992; Soroka and Murrell 1993; Summers 1998), and in Manitoba (Schaber 1992; Timlick et al. 1993; Uddin 2005). These plant bugs, mainly *Lygus* spp. and *Adelphocoris* spp., are pests of alfalfa grown for seed, and cause serious damage when they exceed their economic injury level or threshold. In Manitoba, the plant bug populations in seed alfalfa are usually controlled twice a season, firstly by the end of June when the plant is blooming, and secondly late in the growing season in late August.

Mirid plant bugs have recently been observed on buckwheat in Manitoba (Elliott and Wise 2002; Wise et al. 2005). *Lygus lineolaris* (Palisot de Beauvois) is the most abundant plant bug found in buckwheat fields in Manitoba, and there is evidence of nymphal stages developing in the crop. However, the first concern was a large population, mainly of adults, in August and September.

The sources of the late season population of plant bugs in buckwheat and seed alfalfa fields are not known, despite the suggestion they disperse from nearby senesced hosts. Concerns about the late growing season populations of plant bugs in buckwheat and seed alfalfa, along with uncertainity about the role of early growing season populations in buckwheat, and about the occurrence and structure of these populations provided the stimuli for initiating this research. The present study was designed to deal with these concerns and collect the required information to address the following objectives:

- To study the current seasonal occurrence of plant bug and species composition in seed alfalfa and buckwheat.
- To gather information about the quantities and sources of the lygus bugs moving into seed alfalfa and buckwheat field late in the growing season.
- To study the impacts of lygus bug populations on the yield of buckwheat.
- To study the impacts of plant bug populations late in the growing season on the yield of seed alfalfa.
- To find ways of managing plant bugs in seed alfalfa and buckwheat.

Thesis Organization

The thesis is divided into four main chapters: General Introduction, Literature Review, Research and General Discussion. The Literature Review is an introduction to information on the origins of alfalfa and buckwheat and their importance with particular reference to Manitoba, along with the distribution, importance, biology, sampling, movement and management of plant bugs. In the research chapter, I describe new research examining the species composition, late season population movements, impact and management of plant bugs, particularly *Lygus* species, in buckwheat and alfalfa crops in Manitoba. The chapter addresses the five objectives outlined above, and is divided into four parts, each in the style of a scientific paper. In General Discussion, I relate important findings and observations from the four parts of the Research chapter to provide general conclusions on the species composition, movements, impacts and management of plant bugs found in buckwheat and seed alfalfa crops in Manitoba.

CHAPTER II

Literature Review

Alfalfa crop, with particular reference to seed production in Manitoba

Alfalfa, *Medicago sativa* Linnaeus, is an important and popular forage crop worldwide. It probably originated in Asia more than 3300 years ago, and was first introduced to North America in Georgia in 1736, but did not become established as an important crop until 1850 in California (Goplen et al. 1987). A cold-hardy strain of alfalfa was introduced to the northern United States from Germany in 1857, and then to Canada, where several other strains were selected (Goplen et al. 1987).

Fresh or processed alfalfa is a nutritional feed for livestock, and humans consume alfalfa sprouts (Summers 1998). Alfalfa also enhances soil structure, improves water conditions, reduces salinity and fixes atmospheric nitrogen to increase soil fertility (Summers 1998).

Two production systems for alfalfa are found in the Canadian prairies, one for the production of animal feed and the other for seed production (Goplen et al. 1987). Alfalfa crops for feed production are usually mown one to three times in the growing season (Harper et al. 1990) to provide feed for livestock. The crop is either used directly by animals as hay or silage, or dehydrated for protein concentration and long-term storage (Goplen et al. 1987). Insect pests in hay fields are disturbed by mowing, which promotes for their dispersal and keeps them at low levels that usually do not cause economic damage (Schaber et al. 1990b). In the seed production system, leafcutting bees are used to increase pollination and yield of the seeds. The crop is swathed and at maturation, normally in September on the Canadian Prairies, the seeds are harvested by combine (Goplen et al. 1987). Alfalfa seed production value reached a record near $ 20 million Canadian in 2002, although it decreased by almost half in

the following years (Manitoba Agriculture, Food and Rural Initiatives 2005c). The dominant insect pests of seed alfalfa in western Canada are two groups of plant bugs (Hemiptera: Miridae), the alfalfa plant bug, *Adelphocoris* spp. and plant bugs of the genus *Lygus* of which the most important is the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) (Hemiptera: Miridae) (Goplen et al. 1987; Soroka 1991; Harris 1992; Schaber 1992; Uddin 2005). Another important insect pest of seed alfalfa in Manitoba is the pea aphid, *Acrythosiphon pisum* Harris (Homoptera, Aphididae) (Uddin 2005). Insect pests have the potential to cause more economic damage to seed alfalfa than forage alfalfa because the crop is exposed to insect attack throughout most of the season. The main method for prevention of this damage in North America is use of insecticides. Typically, one or two applications of insecticide are made in Manitoba during the growing season of seed alfalfa (Uddin 2005), an early season application during late June and a late season application about the third week of August. In Manitoba, growers usually apply an insecticide just before introduction of leaf-cutting bees for pollination, as a clean-up treatment to control both aphids and plant bugs (Uddin 2005). When leaf-cutting bees are removed from the seed crop in August, producers often notice considerable numbers of plant bugs and apply a second spray.

Buckwheat crop origin and importance

Buckwheat, *Fagopyrum esculentum* Moech., has been cultivated in Manitoba since the early settlers from Ukraine brought its seeds to the Province. The cultivated area of buckwheat in Manitoba in 2005 was about 4,000 ha which produced 46,000 tonnes of seed (Manitoba Agriculture, Food and Rural Initiative 2005a). Manitoba

buckwheat contributes about 70% of Canadian buckwheat production (Manitoba Buckwheat Growers' Association 1998); most of this production is exported to the south Asian market for the noodle manufacturing.

In Canada, no insecticides are registered for use on buckwheat, and until recently, insect pests were not considered a major impediment to buckwheat production. Recently in Manitoba, large numbers of adult lygus bugs have been observed on flower and seed heads of buckwheat near the end of the growing season, and earlier in the growing season immature lygus bugs are present in the crop (Wise et al. 2005). Before the completion of my research no information was available on the effects of lygus bugs on buckwheat yield and quality.

Plant bugs distribution and importance

Family Miridae, the plant bugs, is the largest family in order Hemiptera; with many important pests of economic crops worldwide (Wheeler 2001). Lygus bugs, *Lygus* spp., and alfalfa plant bugs, *Adelphocoris lineolatus* (Goeze), are the most widely distributed economic pests of this family.

Plant bugs of the genus *Lygus* are pests of many crops grown for seed (Strong et al. 1970). Pest species are found in North America, Europe, Asia, much of the Middle East and Africa (Gupta et al. 1980). In North America, 34 species are known, and 22 occur in the Prairie Provinces in Canada (Kelton 1980). At least nine species of the genus *Lygus* are of major importance to agriculture in North America, Europe and Asia (Kelton 1975). In North America, the more important species are *L. lineolaris*, *L. hesperus* (Knight), *L. elisus* (Van Duzee) (Gupta et al. 1980) and *L. borealis* (Kelton) (Kelton 1980). In the eastern and southeastern United States and in

Canada, the tarnished plant bug, *L. lineolaris*, can cause damage to more than 130 economically important crops, including 21 of the 30 most important crops in the United States (Young 1986). Affected crops include seed alfalfa (Shull et al. 1934; McMahan and Arrand 1955; Gupta et al. 1980), sunflowers, *Helianthus annuus* L., (Charlet 2003), apples, *Malus pumilla* P. Mill., (Hall 1974; Boivin and Stewart 1982; Weires et al. 1985; Michaud et al. 1989), bird's-foot trefoil, *Lotus corniculatus* L., (Neunzig and Gyrisco 1955; Wipfli et al. 1990), carrots, *Daucus carota* L., (Kho and Braak 1956; Scott 1983), cotton, *Gossypium* sp., (Pack and Tugwell 1976; Tugwell et al. 1976; Horn et al. 1999; Greene et al. 1999; Layton 2000), canola, *Brassica* sp., (Butts and Lamb 1990 a & b, 1991a & b; Turnock et al. 1995; Leferink and Gerber 1997; Wise and Lamb 1998a & b), wheat, *Triticum* spp., (Wise et al. 2000), green beans, *Phaseolus vulgaris* L., (Khattat and Stewart 1975; Stewart and Khattat 1980a & b), lima beans, *Phaseolus lunatus* L., (McEwen and Harvey 1960), asparagus, *Asparagus officinalis* L., (Wukasch and Sears 1981; Grafius and Morrow 1982), peaches, *Prunus persica* (L.) Batsch, (Rings 1958; Pree 1985), pears, *Pyrus* spp., (Webster and Spuler 1931), soybeans, *Glycine max* (L.) Merr., (Broersma and Luckmann 1970), strawberries, *Fragaria* spp., (Schaefers 1980; Mailloux and Bostanian 1988; Handley and Pollard 1993a & b), tomato, *Solanum lycopersicum* L., (Davis et al. 1963) and nursery stock (Haseman 1918). In the western parts of Canada and United States and southwestern United States *L. hesperus* and *L. elisus* are serious pests of seed alfalfa (Sorenson 1939), beans (Shull 1933; Middlekauff and Stevenson 1953; Elmore 1955; Scott 1969), cotton (Cassidy and Barber 1939), beets, *Beta vulgaris* L., (Hills and Taylor 1950; Carlson 1961), strawberries (Allen and

Geode 1963), carrots (Scott et al. 1966; Scott 1969, 1970) and other less important crops (Addicott and Romney 1950; Koehler 1963).

In the Canadian Prairies, lygus bugs are major pests of alfalfa (Craig 1983; Uddin 2005) and canola (Butts and Lamb 1991a). The most common species found on these crops are *L. elisus*, *L. borealis*, and *L. lineolaris* (Craig 1983; Butts and Lamb 1990a & b; Leferink 1992; Wise and Lamb 1998a & b; Otani 2000). The latter species is the most abundant in Manitoba (Timlick et al. 1993).

Alfalfa plant bug, *A. lineolatus*, is a serious pest of alfalfa grown for seed in North America (Hughes 1943; Craig 1961; Craig and Loan 1984a; Murrell 1987; Harris 1992; Soroka and Murrell 1993) and other parts of the world (Romankow 1959; Sedivy 1972; Hori and Kishino 1992). Alfalfa plant bug causes bud blast and flower drop which may eliminate the seed production in years with severe infestations (Sedivy and Kodys 1972). This insect also can cause damage to other forage crops like birdsfoot trefoil (Wipfli et al. 1990).

Biology of lygus bugs

Unlike most mirids which overwinter as eggs, plant bugs in the genus *Lygus* overwinter as adults and then emerge in the spring to feed on suitable host plants (Kelton 1975). Female inserts eggs in plant stems, causing minor injury (Painter 1929 and Wilson and Olson 1990). The preoviposition period of *L. lineolaris* ranges from 6.8 days at 32°C to 11.5 days at 21°C (Bariola 1969); for *L. hesperus* this period is 27 days at 12.8°C, 17 days at 15.6°C and 7 days at 26.7°C (Strong et al. 1970). Eggs develop and hatch in less than two weeks at 20°C, with no oviposition occurring among females held at 16°C (Ridgway and Gyrisco 1960a; Bariola 1969). No eggs