Journal of

Entomology

ISSN 1812-5670

Academic
Journals Inc.

www.academicjournals.com

Journal of Entomology 4 (3): 225-230, 2007
ISSN 1812-5670

Evaluation of Plant Yield Responses to Artificial Infestations of *Lygus elisus* (Van Duzee) and *Nysius raphanus* (Howard) on Spring Canola

[1]N. Demirel and [2]W. Cranshaw
[1]Department of Plant Protection, Faculty of Agriculture,
Mustafa Kemal University, 31034, Antakya, Hatay, Turkey
[2]Department of Bioagricultural Sciences and Pest Management,
Colorado State University, Ft. Collins, CO 80523, USA

Abstract: A two-year study was conducted to evaluate the relationship of plant yield responses to artificial infestations of the Pale Legume Bug (PLB) and False Chinch Bug (FCB) on spring canola in Colorado, USA. Yield losses with both insect species were greater at early flower stages infestations than at early pod stages infestations. A significant yield reductions were caused by 8 PLB/head at early flower stages and 16 PLB/head both stages of IMC204 and 16 PLB/ head at early flower stages of IMC205. Significant yield losses in 2001 were resulted in 40 FCB/head at early pod stages of IMC204. However, yield losses in 2002 were significantly higher at early flower stages than early pod stages. A 20 and 40 FCB/head resulted in 72 and 85% yield losses comparing with 0FCB/head on the cultivar IMC204. In addition, the cultivar IMC205 had 79% yield losses by 40 FCB/head. In conclusion, the spring canola yield responses varied among PLB and FCB/head and their stages.

Key words: *Lygus elisus* (Van Duzee) (Heteroptera: Miridae), *Nysius raphanus* (Howard) (Hemiptera: Lygeaidae), artificial infestation, plant yield response, spring canola

INTRODUCTION

The pale legume bug (PLB), *Lygus elisus* Van Duzee and false chinch bug (FCB), *Nysius raphanus* (Howard) (Hemiptera: Lygeaidae), are significantly important pests on canola cultivars in Colorado (Demirel, 2003; Demirel *et al*., 2005; Demirel and Cranshaw, 2006). Pale legume bug, significantly economical pests of a wide variety of host plants (Kelton, 1975; Wheeler, 2001) is widely distributed throughout the Rocky Mountain regions of North America (Kelton, 1975; Demirel, 2003; Demirel *et al*., 2005). *Lygus* are important pests of oilseed brassicas (Kelton, 1975; Schwartz and Foottit, 1992; Schuh and Slater, 1995) feeding primarily on buds, flowers, pods and seeds (Lamb, 1989). Visible injuries to *B. napus* L. (canola, rape) and *B. campestris* L. (oilseed mustard) appear as surface lesions and can cause buds and flowers to abscise and seeds to collapse. *Lygus* damage to buds and flowers usually results in a net reduction in the yield of canola seed, although the plants compensate to some extent by replacing lost buds and flowers (Butts and Lamb, 1990).

The false chinch bug, originally described from Kansas by Howard (1872), is of the most serious pest among North America species of *Nysius* (Ashlock, 1977). False chinch bug has a broad host range but prefers plants of the Brassicaceae (Howard, 1872; Knowlton, 1934; Sweet, 2000) and is a key pest of canola grown in Colorado (Demirel, 2003; Demirel and Cranshaw, 2006). They usually feed on stems, leaves, flower and seed-pod of canola and cause significant injury at older growth stage of

Corresponding Author: N. Demirel, Department of Plant Protection, Faculty of Agriculture, Mustafa Kemal University, 31034, Antakya, Hatay, Turkey Fax: 90(326)2455832

plants, e.g., during flower and seed-pod development (Demirel, 2003). Injury by FCB is caused from removal of sap, which is sucked from plants during feeding. Plant damage usually results when masses congregate upon plants and feed, causing wilting (Byers, 1973; Howard, 1872; Knowlton, 1934). An increasing adult population in canola can also lead to increased problems in subsequently seeded crops (Buntin *et al*., 2002; Demirel, 2003).

The canola, developed in the 1970s by the plant-breeding, is one of the most important oilseed crops in the world (Shahidi, 1990). Based on main stems, canola was divided into five different stages that were preemergence, seedling, rosette, flower and ripening (Harper and Berkenkamp, 1975). These studies were conducted at two different stages, at the early flowering stage, similar to Stage 4.2 and at the early pod stage, similar to stage 5.2, were described by Harper and Berkenkamp (1975).

The purpose of this study was to determine the specific effect of *L. elisus* and *N. raphanus* to spring canola under conditions of controlled infestation at both early flower and pod stages.

MATERIALS AND METHODS

Plant Yield Response Trials in 2001

Trials were conducted at the Cargill Oilseed Research Center (CORC) in Fort Collins, Colorado. Trials on the cultivar IMC204 at CORC were established by seeding on 26 April, each plot consisted of 6 m long and two double-row beds with 76 cm row spacing. Individual plots were arranged in a randomized complete block design with 10 replications and five treatments. Approximately similar size plants were selected and bagged for infestation. Bags were placed over only one flowering and pod branch of the plants which will subsequently be termed head. Before infestation in each plot, five canola heads were selected of approximately equal size. One of these served as a non-bagged control and four of them were bagged. The bags were of 12×20 cm polypropylene mesh (Applied Extrusion Technologies, Specialty Nets and Nonwovens, Middletown, Delaware) primarily used for confining heads during plant breeding. The bags were snuggly fastened to the stem with a twist-tie. Three infestation levels of PLB and FCB were introduced into the bagged heads; 2, 8 and 16 PLB/head and 10, 20, 40 FCB/head, two were retained as a bagged control in trials. Adults of PLB and FCB were field-collected 1 to 2 days prior to infestation and maintained in a holding cage. They were then aspirated into individual vials for introduction into the bagged head.

Infestation occurred at two plant growth stages. The early flowering stage was comparable to Stage 4.2, when there are many flowers opened and lower pods are elongating. These plants were bagged on 28 June and PLB and FCB introduced into the bags the same day. Infestations were also made at the early pod stage, comparable to stage 5.2, with the seeds in lower pods green. These plants were bagged on 11 July and PLB and FCB introduced into the bags at the same day. Plots were harvested on 16 August. Both infested and non-bagged heads were cut, with or without the bag intact and hung for drying. The pods were then crushed to release the seeds and separated from other debris by use of sieves. Data from each cultivar, growth stage and number of PLB and FCB per head yield in all trials were analyzed using the Least Significant Difference (LSD) Multiple Comparison Test and the linear regression ($p<0.05$, SAS Institute, 1990). In addition, significant differences of 0 PLB and 0 FCB per head yield versus non-bagged yield for each cultivar and growth stages in all trials were performed by t-test ($p<0.05$, SAS Institute, 1990).

Plant Yield Response Trials in 2002

Trials were conducted at the Colorado State University Horticulture Research Center (HFRC). Prior to seeding pesticide use on the plots consisted of a pre-emergence application of trifluralin for weed control. Four different plots at HFRC were established by seeding on 3 April, each plot consisted of 6 m long and two double-row beds with 76 cm row spacing. Trials repeated with two spring canola cultivars, IMC204 and IMC205. Individual plots were arranged in a randomized complete block design with 4 replications and five treatments. Pesticide of carbaryl applied on 10 May for control of western black flea beetle.

Three infestation levels of PLB and FCB were introduced into the bagged heads; 2, 8 and 16 PLB/head and 10, 20, 40 FCB/head, two were retained as a bagged control in trials. Adults of PLB and FCB were field-collected 1 to 2 days prior to infestation and maintained in a holding cage. They were then aspirated into individual vials for introduction into the bagged head.

Bagging of heads at the early flower stage was done on 19 and 23 June and field collected PLB and FCB were introduced into bags on 25 June. For evaluations during the early pod stage, canola heads were covered with bags on 14 and 15 July and PLB and FCB were introduced 17 July. Bagging of heads and management of plots was similar to that of 2001. Both infested and non-bagged heads were harvested on 21 August, cutting with or without the bag intact and hung for drying. When dry, pods were crushed to release the seeds and seeds were separated from other debris by use of sieves. After this procedure, seed was further cleaned using Agriculex CB-1 (column blower) to sort out seed from plant debris. Data from in all trials were analyzed similar to those of 2001.

RESULTS AND DISCUSSION

Canola cultivars showed greater yield reduction by PLB when plants were infested with insects at the early flower stages comparing with early pod stages in 2001(Table 1). A 39 and 56% of yield reduction occurred with an 8 and 16 PLB/ head comparing with control treatment at early flower stages, whereas yield losses were 23% with 16 PLB/ head at early pod stages. An 82% yield losses occurred with 16 PLB/head comparing with control treatment on IMC205 at the early flower stages and yet there were no yield losses observed at early pod stages in 2002. Moreover, IMC204 had no yield loss with all treatment at early flower and pod stages.

A significant yield loss resulted in 40 FCB/head at early pod stages of IMC204 in 2001 (Table 2). However, there was no significant yield loss among treatments at early flower stages. However, significantly higher yield losses were caused by FCB at early flower stages comparing to early pod stages in 2002. A 20 and 40 FCB/head on the cultivar of IMC204 resulted in 72 and 85% yield losses comparing with 0FCB/head. In addition, the cultivar IMC205 had 79% yield losses with 40 FCB/head. However, there were no yield losses on both IMC204 and IMC205 at early pod stages in 2002. Both IMC204 and IMC205 had significantly lower yield at early flower stages comparing with early pod stages (Table 3). In addition, the only IMC204 had significant yield losses with non-bagged control at early pod stages comparing with 0PLB and 0FCB/head control in 2001 (Table 3). There were no significant yield losses occurred the rest of evaluation period and stages of canola.

Table 1: Yield (g./head) of canola cultivars bagged and infested with different numbers of Pale Legume Bug (PLB) during the early flower and the early pod stages

				No. PLB/Head[y]								
Trials[z]	Years	Cultivars	Growth stage[w]	0	2	8	16	Slope	Intercepts	df	F	p<0.05
1	2001	IMC204	EF	1.95ab	2.72a	1.18bc	0.86c	-0.096	2.553	3,36	4.560	0.01411
1	2001	IMC204	EP	6.21a	5.38ab	5.42ab	4.80b	-0.119	2.177	3,36	3.688	0.021
2	2002	IMC204	EF	3.21a	2.89a	1.73a	2.06a	-0.076	2.668	3,12	0.229	0.87422
2	2002	IMC204	EP	2.14a	2.99a	3.15a	3.41a	0.063	2.119	3,12	0.401	0.755
3	2002	IMC205	EF	1.45a	2.45a	2.02a	0.26b	-0.096	2.233	3,12	1.254	0.033
3	2002	IMC205	EP	4.31a	3.41a	3.32a	3.14a	-0.055	3.324	3,12	0.659	0.593

[z]Trial one was conducted at CORC in 2001 and the others were conducted at HFRC in 2002;[w]Early flower stage (EF) and Early pod stage (EP); [y]Means followed by the same letter in a row do not differ significantly ($p<0.05$, LSD, Regressions Analysis)

Table 2: Yield (g/head) of canola cultivars bagged and infested with different numbers of False Chinch Bugs (FCB) during the early flower and the early pod stage

Trials[z]	Years	Cultivars	Growth Stage[w]	No. FCB/Head[y] 0	10	20	40	Slope	Intercepts	df	F	p<0.05
1	2001	IMC204	EF	2.39a	2.13a	2.10a	1.99a	0.0005	2.451	3,36	0.304	0.822
1	2001	IMC204	EP	7.52a	6.72ab	7.05ab	5.66b	-0.0373	8.044	3,36	5.870	0.002
2	2002	IMC204	EF	1.57ab	1.99a	0.44b	0.24b	-0.0412	2.456	3,12	2.876	0.032
2	2002	IMC204	EP	3.23a	2.35a	2.39a	2.49a	-0.0137	3.161	3,12	0.244	0.864
3	2002	IMC205	EF	3.27a	1.68a	1.33a	0.68b	-0.0586	3.778	3,12	0.891	0.047
3	2002	IMC205	EP	5.47a	4.62a	4.11a	4.81a	-0.0135	5.381	3,12	0.985	0.432

[z]Trial one was conducted at CORC in 2001 and two and three were conducted at HFRC in 2002;[w]Early flower stage (EF) and Early pod stage (EP); [y]Means followed by the same letter in a row do not differ significantly (p<0.05, LSD, Regressions Analysis)

Table 3: Yield (g/head) of canola cultivars bagged and infested with different numbers of Pale Legume Bug (PLB) and False Chinch Bug (FCB) during the early flower and the early pod stages

			Early flower stage [y]				Early pod stage [y]			
Trials[z]	Year	Cultivars	0PLB	Non-bagged	0FCB	Non-bagged	0PLB	Non-bagged	0FCB	Non-bagged
1	2001	IMC204	1. 95a	1.86a	2.39a	2.82a	6.21a	3.24b	7.52a	4.05b
2	2002	IMC204	3.22a	2.52a	1.57a	4.24a	2.14a	2.67a	3.23a	2.23a
3	2002	IMC205	1.45a	2.55a	3.27a	2.00a	4.32a	4.45a	5.47a	4.26a

[z]Trial one was conducted at CORC in 2001 and the others were conducted at HFRC in 2002;[y]At each growth stage, means followed by the same letter in a row do not differ significantly (p<0.05, t-test)

In previous studies also indicated that yield losses were higher at early flower stages and also comparisons of 10% yield loss occurred with infestations of 3.1-5.6 PLB/head (avg. 3.3) with early flowering stage infestations and 3.4-19.0 PLB/head (avg. 8.72) at early pod stage infestations (Demirel, 2003). On the other hand, the other studies indicated that Plant growth stage was a factor with greatest losses occurring with *Lygus* infestations present during early pod stage (Butts and Lamb, 1991). On yield losses associated with various levels of *Lygus* was determined by sweep net sampling (Butts and Lamb, 1991). The highest loss from a mixed population of *Lygus* occurred at densities of 52 *Lygus* bugs per 10 sweeps at the early pod stages. Moreover, when densities at this stage were 1-5 *Lygus* bugs per 10 sweeps, yield losses of 14 to 18% were observed. A proposing an economic threshold of 15 plant bugs per 10 sweeps in canola at the end of flowering or at the beginning of pod formation, based on crop prices and control cost from 1989 to 1992 (Wise and Lamb, 1998). At slightly later stages of plant growth their proposed economic threshold in canola was 20 plant bugs per 10 sweeps. Previous report by Demirel (2003) indicated that yield losses by FCB were greater at early flower stages infestations than at early pod stages infestations. For example, in the first trial, averaged yield losses over all cultivars were 43, 68 and 69% with infestations of 10, 20 and 40 FCB/head, respectively, compared to the non-infested control at early flower stages in 2001. On the contrary, averaged yield losses were 11, 26 and 23% with the same infestations levels at early pod stages. In addition, in the second trial, averaged yield losses over all cultivars were 26, 58 and 55% with infestations of 10, 20 and 40 FCB/head at early flower stages. On the other hand, averaged yield losses were 35, 20 and 35% with the same infestations levels at early pod stages. Furthermore, the cultivar responses to FCB may also be incorporated into FCB yield reductions (Demirel, 2003). Therefore, yield losses from FCB infestation varied among cultivars during the early flower and pod stages in both years. Number of FCB required causing 10% yield loss at early flowering stage infestation in four trials ranged from 6.1-39.4 FCB/head (avg. 14.78) (Demirel, 2003). In addition, at early pod stage 10% yield loss resulted from average FCB infestations of 15.4-109.8 (avg. 41.68).

In conclusion, significant yield reduction by PLB and FCB occurred at early flower stages of both cultivars. A significant yield reductions were resulted in 8 PLB/head at early flower and 16 PLB/head both stages of IMC204 and 16 PLB/ head at early flower stage of IMC205. There was no significant yield loss among treatments at early flower stages, whereas a 40 FCB/head caused significant yield loss at early pod stages of IMC204 in 2001. Yield losses by FCB were significantly higher at early flower stages than early pod stages in 2002. A 20 and 40 FCB/head on the cultivar of IMC204 resulted in 72 and 85% yield losses comparing with 0FCB/head. In addition, the cultivar IMC205 had 79% yield losses with 40 FCB/head. However, there were no yield losses on both IMC204 and IMC205 at early pod stages in 2002.

ACKNOWLEDGMENTS

We would like to thank Karen Kramer, Loretta Mannix, Phyllis Pineda, Matt Camper, Jeff Owens, Kristine Wolfe, Brain Moore and Muhammed Al-Doghairi for their valuable help in my fieldwork. In addition, we would greatly appreciate to Dana Christenson for taking care of our research plots at the Horticulture Field Research Center (HFRC) in Ft. Collins, CO. We are also indebted to Dr. Lorin DeBonte and Steve Stadelmaier, in which works the Cargill Oilseed Research Center (CORC) in Ft. Collins, CO, for providing canola seed our research and sharing with us valuable information about canola.

This project was supported by Colorado Agricultural Experiment Station.

ND was supported by the Ministry of National Education of Republic of Turkey.

REFERENCES

Ashlock, P.D., 1977. New records and name changes of North American Lygaeidae (Hemiptera: Heteroptera: Lygaeidae). Proc. Entomol. Soc. Wash., 79: 575-582.

Buntin, G.D., B.M. Cunfer, D.V. Phillips and J.R. Allison, 2002. Sequence and rotation effects on pest incidence and yield of winter wheat and canola double-cropped with pearl millet and soybean. pp: 342-343. In: Proc. 25th Southern Conserv. Conf. Spec. Rpt. No. 1 Alabama Agric. Expt. Stn.

Butts, R.A. and R.J. Lamb, 1990. Injury to oilseed rape caused by mirid bugs (*Lygus*) (Heteroptera: Miridae) and its effect on seed production. Ann. Applied Biol., 117: 253-266.

Butts, R.A. and R.J. Lamb, 1991. Pest status of *Lygus* bugs (Hemiptera: Miridae) in oilseed Brassica crops. J. Econ. Entomol., 84: 1591-1596.

Byers, G.W., 1973. A mating aggregation of *Nysius raphanus* (Hemiptera: Lygaeidae). J. Kansas Entomol. Soc., 46: 281-282.

Demirel, N., 2003. Integrated pest management studies of the insects affecting oilseed brassicas in Colorado. Ph.D. Dissertation, Colorado State University. Ft. Collins, Colorado, pp: 266.

Demirel, N., W. Cranshaw and A. Norton, 2005. Survey of *Lygus* sp. and an associated parasitoid, *Leiophron uniformis* (Gahan), in Colorado. Southwestern Entomologist, 30: 9-15.

Demirel, N. and W. Cranshaw, 2006. Surveys of False Chinch Bug (FCB), *Nysius raphanus* (Howard) (Hemiptera: Lygaeidae) and their movement on cultivated crops and non-cultivated habitats throughout growing season in Colorado. J. Entomol., 3: 149-155.

Harper, F.R. and B. Berkenkamp, 1975. Revised growth-stage key for *Brassica campestris* and *Brassica napus*. Can. J. Plant Sci., 55: 657-658.

Howard, W.R., 1872. The radish bug-new insect (*Nysius raphanus*, n.sp). Can. Entomol., 4: 219-220.

Kelton, L.A., 1975. The *Lygus* bugs (Genus *Lygus* Hahn) of North America (Heteroptera: Miridae). Mem. Entomol. Soc. Can., 95: 1-101.

Knowlton, G.F., 1934. The false chinch bug, *Nysius ericae* (Schill.). Utah Agric. Expt Stn. Lflt., 43: 2.

Lamb, R.J., 1989. Entomology of oilseed Brassica crops. Ann. Rev. Entomol., 34: 211-229.

SAS Institute Inc., 1990. SAS/STAT User's Guide, Version 6 Edn. SAS Institute Inc., Cary, NC.

Schuh, R.T. and J.A. Slater, 1995. True bugs of the world (Hemiptera: Heteroptera): Classification and Natural History. Comstock Pub. Associates. Ithaca, NY, pp: 336.

Schwartz, M.D. and R.G. Foottit, 1992. *Lygus* bugs on the Prairies, Biology, Systematic and Distributions. In: Technical Bulletin Research Branch Agriculture Canada No. 4E., pp: 44.

Shahidi, F., 1990. Canola and rapeseed: production, chemistry, nutrition and processing technology. Van Nostrand Reinhold, New York, pp: 355.

Sweet, M.H., 2000. Seed and Chinch Bugs (Lygaeidae). pp: 143-264. In: Schaefer, C.W. and A.R. Panizzi (Eds). Heteroptera of Economic Importance. CRC Press, Boca Raton, London, New York, Washington, pp: 828.

Wise, I.L. and R.J. Lamb, 1998. Economic threshold for plant bugs, *Lygus* sp. (Heteroptera: Miridae), in canola. Can. Entomol., 130: 825-836.

Wheeler, A.G.Jr., 2001. Biology of the Plant Bugs (Hemiptera: Miridae): Pests, Predators and Opportunists. Comstock Publishing Associates. Cornell University Press. Ithaca and London, pp: 507.