Insect – agronomic interactions in canola integrated pest management

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ABSTRACT

Much previous research in pest management in canola has focused on developing strategies for reducing infestation levels of single pest species (e.g., bertha armyworm), or individual pest groups (e.g., insects) without regard to possible detrimental effects of these control strategies on other pests. The aim of our research has been to integrate insect management strategies with agronomic practices to ensure that control recommendations are compatible among different pest groups and lead to integrated crop management. Field studies were undertaken in Alberta, Canada, to determine the effects of fertility regime, crop cultivar, time of weed removal, seeding date, and seeding rate on seed yields and infestations of insects and weeds. Increasing soil fertility resulted in improved canola seed yields, but produced plants with larger root systems that made them more vulnerable to attack by root maggots (*Delia radicum* (L.)). Altering seeding date from 'normal' spring planting times to fall or early spring seeding had no effect on root maggot infestations. Nevertheless, the higher seed yields derived from early seeding more than compensated for insect feeding damage. Delaying weed removal from the two- to the six-leaf stages of canola development increased interspecific plant competition and depressed yields, but root maggot damage declined when weeds were removed later. Some canola cultivars were less susceptible to yield losses from insect pest attack than others, presumably because they could better compensate for herbivory. To date, we have identified several practices that are effective against multiple pests, or at least are effective toward one and without impact on others. Such research will serve as an important foundation toward integrated crop management in canola.

Key Words: integrated crop management, root maggots, fertility, weed control

INTRODUCTION

Yield and crop quality in canola agroecosystems are affected by several biotic and abiotic factors; consequently, optimal production practices must ensure that management strategies for different pests are compatible and integrated. Strategies adopted to manage one pest species should not cause substantial increases in infestation levels of another. Our research has focused on integrating insect and weed management strategies with agronomic practices to ensure that control recommendations for different pest groups lead to integrated crop management.

In central Alberta, Canada, pests of greatest economic concern in canola cropping systems include monocot and dicot weed species and root maggots (*Delia* spp.) (Diptera: Anthomyiidae). Early-emerging weeds are particularly damaging to canola because they deprive crop plants of moisture, nutrients, and space during a critical stage of development (O'Donovan 1992). Although early weed removal is now an accepted and widely promoted management practice for optimal crop production in canola, this practice has potential impact on pests other than weeds. Similarly, fertilizer management is a critical component of successful canola production, but alterations made to soil fertility can also affect insect and weed infestations. Other agronomic factors, including seeding date, seeding rate, and cultivar can interact with each other and infestations of different pests, requiring an holistic, integrated crop management approach for development of sustainable production practices.

The objective of our study was to investigate concomitant effects of various agronomic factors on weed and root maggot infestations, including time of weed removal, fertility regime, seeding rate, and seeding date, and to identify optimal management practices for weeds and root maggots in light of their relative impacts on crop yield.

MATERIALS AND METHODS

Field experiments were conducted at Lacombe and Beaverlodge, Alberta, Canada from 1999 to 2001 and investigated effects of time of weed removal on weed and root maggot infestation levels, and fertilizer application rate, cultivar, seeding rate, and seeding date on root maggot infestations. Each of six experiments investigated factorial combinations of three agronomic factors concomitantly: time of weed removal-cultivar-seeding date; time of weed removal-cultivar-herbicide rate; time of weed removal-cultivar-fertilizer rate; time of weed removal-fertilizer placement-nitrification inhibitor; fertility level-cultivar-seeding rate; and seeding date-cultivar-seed coating type.

In experiments where time of weed removal was an experimental factor, weeds were removed with herbicide as closely as possible to the two-, four-, and six-leaf stages of canola development, and when fertilizer application rate was investigated, applications of N, P, K, and S were made at 0.5, 1.0, and 1.5 times the recommended rates based on soil test results before seeding. Where seeding rate was varied, rates were 2.7, 5.3, 8.0, and 10.6 kg per ha, and the seeding dates investigated were early fall (late October), late fall (mid-November), early spring (late April), and late spring (mid May). The *Brassica napus* cultivars evaluated comprised Exceed, InVigor 2153, LG 3295, and 45A71.

Treatment plots measured 4 by 12 m, and were seeded with a Conserva Pak® drill. For the weed removal studies, monocot and dicot weed populations were determined separately before each time of herbicide application in 0.5 m^2 quadrats positioned within each plot. At harvest, a sample of 25 canola roots was collected randomly from each plot. Roots were bagged, labelled, washed, and rated for degree of root maggot damage using the semi-quantitative scale of Dosdall et al. (1994). Root maggot damage ratings of canola taproots were analysed separately for each experiment with the PROC MIXED procedure of SAS, with blocks as random effects, and depending on the experiment, with site, time of weed removal, fertilizer rate, seeding date, and seeding rate as fixed effects.

RESULTS

Time of weed removal significantly affected root maggot damage to canola taproots (Fig. 1a). With a total of 10 site-years of data, damage to taproots declined by 6% with a delay in weed removal from the two- to the six-leaf stages of canola development. Nevertheless, yield improvements achieved with early weed removal exceeded the yield benefit derived by lowered root maggot damage when weeds were removed later.

Root maggot infestations were also significantly affected by fertility regime, with greatest damage occurring at the highest levels of soil fertility (Fig. 1b). Although the yield advantage from improved plant nutrition at high rates of fertilization was diminished by losses due to greater attack by root maggots, highly fertilized plants were better able to compensate for herbivory than plants grown with less fertilizer.

Increases in canola seeding rate were associated with statistically significant decreases in root maggot damage (Fig. 1c). Least damage to canola occurred at the highest seeding rate. Seeding date did not appear to influence crop damage by root maggots (Fig. 1d). Regardless of whether plots were seeded in early or late fall, or early or late spring, mean damage ratings per plant by root maggots were usually similar. Canola cultivars varied in their susceptibilities to attack by root maggots. Among the varieties evaluated, LG3235 and Exceed were least and most susceptible to infestation, respectively.

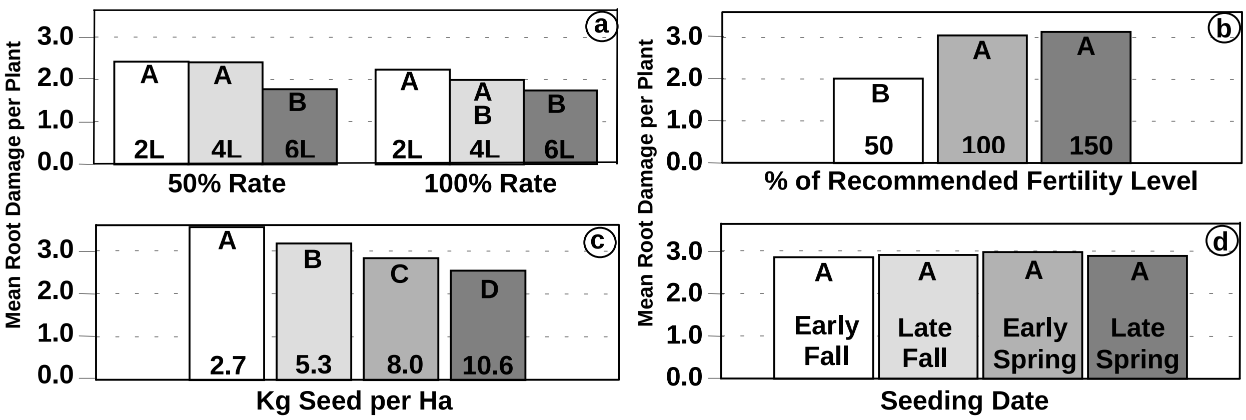

Fig. 1. The effects of various agronomic parameters on root maggots (*Delia* spp.) in canola, including time of weed removal at the two-, four-, and 6-leaf stages of canola and treated with 50 and 100% of herbicide label rates (Fig. 1a); fertilizer application rate at 50, 100, and 150% of recommended (Fig. 1b), seeding rate at 2.6, 5.3, 8.0, and 10.6 kg per ha (Fig. 1c), and fall and spring seeding dates (Fig. 1d).

DISCUSSION

Although early weed removal is routinely recommended for optimal canola yields (Clayton et al. 2002), this practice can also be associated with increased root maggot damage. The most plausible explanation for this effect relates to the behavioural sequence of events that precedes oviposition in mated, gravid root maggot females. Female flies are restricted to egg-laying on host plants of the family Brassicaceae. Females must make an average of four spiral flights before egg deposition on a host plant (Kostal and Finch 1994), where a female lands on a suitable host, takes flight, lands again on a suitable host, and so on, until on average four consecutive landings have occurred. In heterogenous environments where canola plants are interspersed with weeds, it is less likely for females to achieve four consecutive landings than in weed-free situations.

Improved soil fertility was associated with increased root maggot damage to canola. Plants grown in well fertilized conditions tended to be larger than plants grown with less fertilizer. Root maggot females select plants with larger basal stems for egg-laying (Dosdall et al. 1996), and this may explain the increased damage to well fertilized plants.

We observed no differences in root maggot damage among plants seeded on different dates in fall or spring, indicating that fall seeding of canola does not predispose plants to greater damage.

Cultivars varied in their susceptibilities to attack by root maggots. This concurs with earlier research which showed that *B. napus* genotypes can vary considerably in root maggot susceptibilities due to antixenosis resistance expressed to varying degrees among varieties (Dosdall et al. 1994).

Although delayed time of weed removal was associated with less crop damage by root maggots, highest yields were achieved with early weed removal (two- and four-leaf stages). Plants grown in soil with low fertility also had less root maggot damage, but highly fertilized plants were better able to compensate for root maggot attack. Early weed removal and attaining recommended levels of soil fertility should remain integral components of optimal crop management, but maintaining small weedy backgrounds has potential for reducing root maggot infestation levels and enhancing crop yield.

The integrated management of weeds and root maggots in canola will rely on identifying practices that are effective against both weeds and root maggots, or at least are effective toward one and without impact on the other. For example, increasing seeding rate reduces damage from root maggots (Dosdall et al. 1996), and also depresses competitive interference by weeds (O'Donovan 1994). Widening canola row spacing lowers root maggot damage (Dosdall et al. 1998), but does not appear to affect weed infestations (O'Donovan 1994). In addition, planting cultivars like LG3235 with low susceptibility to root maggot attack can enhance crop competitiveness and facilitate sustainable crop management.

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