Impact of soil tillage and nitrogen fertilization on insect pests of canola in Eastern Canada

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Introduction

Spring canola (*Brassica napus*L.) is an important crop in Canada. In 2010, over 10.4 milliontons (t) of rapeseed was grown on over 7.2 millions of hectares (ha).Nearly all of this production (99%) is from the provinces of Manitoba, Saskatchewan and Alberta. However, the mean seedyield in Western Canada is 1.7 t ha-1 compared to 2.5 t ha-1 in Ontario and 2.2 t ha^{-1} in Quebec (StatsCanada, 2010). The crop management systems used in Western Canadadiffer from the Eastern agricultural practices where fields are usually smaller, thus the production more intensive.

In Western Canada and Europe, canola fields can beunder high pressureduetophytophagousinsects. Since2001, two canola pestsfromEurope havesettledin Quebec: the cabbage seedpod weevil(*Ceutorhynchus*obstrictusMarsham) and the bronzed blossom beetle(*Meligethes* viridescensFabricius). The flea beetles (*Phyllotreta* sp.), tarnished plant bug (*Lyguslineolaris*Palisot de Beauvois) and diamondback moth (*Plutellaxylostella* L.) are also established in Quebec and can be the cause of economic losses.The crop management systems can influence the population dynamic of Brassicaceae specialist and generalist phytophagous insects. In Western Canada, a lower abundance of *Phyllotreta*sp.is observed in canola under zero tillage regimes (Dosdall et al. 1999). It is likely that the accumulation of organic residues from the previous crop and the greater moisture levels in the zero-till system, resultin less suitable conditions for *Phylotreta*sp.in the earlystages of the plant (Milbrathet al. 1995, Dosdall et al. 1999).

Nitrogen absorption by plants can influence its attractiveness to phytophagous insects. Aljmli (2007) observed a positive relationship between N fertilization of canola and abundance of *Meligethes* spp. (Coleoptera, Nitidulidae) found in experimental plots.High N fertilization levels can increase damage caused by*C. obstrictus* larvae, which benefits from an increased supply of nitrogen for its development (Dosdall et al. 2008).However, Aljmli (2007) and Blake et al. (2010) report that a low level of Nand high levels of sulphur are associated with increase of *C. obstrictus*abundance and rate of oviposition.On the other hand,*P.xylostella*(L.)oviposits preferentially, develops more quickly, and achieves higher pupal weights on plants grown at an intermediate level of fertilization (Sarfraz et al. 2009).

So far, no exhaustive study has associated the crop management systems and insect pests in canola in Eastern Canada. Therefore, this project will evaluate the impact of soil tillage and N fertilization on the population dynamics of insect pests of canola. It will also determine if *Phyllotreta*sp. causes more damage in the zero-till plots compared with the conventional plots.

Methodology

Field plot experiments were conducted in 2010 on two sites in Quebec, Canada [Normandin (48º50'N, 73º33'W), on a clayey soil and Saint-Augustin-de-Desmaures (46º44'N, 71º31'W), on a loamy soil].The experimental design was a split-plot with four replications. Main plots were soil tillage (conventional and zero-till) and nitrogen fertilizer sources (urea, ammonium nitrate and slow-release fertilizer) and rate (0-50-100-150 kg ha-1) were subplots. Plot size was 1.62 m x 5 m with an inter-row spacing of 0.18m.The previous crop at both sites was barley which straw was harvested. Conventional tillage (CT) consisted of a fall moldboard ploughing with two passes of a field cultivator in the spring. Zero-till (ZT) had no tillage performed, except the use of a no-till drill for the sowing. Before seedings in the ZT plots, complete phosphorus (P) and potassium (K) fertilization was applied, as well as 20 kg ha^{-1} of N. The rest of the N fertilization was applied at the rosette stage (growth stage 2.4-2.6, Harper and Berkenkamp 1975) in the appropriate treatment. In the CT plots, the complete NPK fertilizers were applied before sowing and incorporated using a field cultivator.Phosphorus and K were applied according to soil analysis and thelocal fertilizer recommendations (CRAAQ 2003).Invigor 5030LL spring canola was seeded at a rate of 125 seeds m^{-2}, on May 16th and 18that St-Augustin and Normandin respectively.Seedswere coated with fungicides (carbathiin, thiram, and metalaxyl) to reduce infestations by seedling phytopathogens, and with a *Phyllotreta*sp. insecticide (clothianidin). Liberty herbicide was applied at the three leaf stage of canola.

Feeding damage by the flea beetles was assessed by estimating the percentage of cotyledonand true leaf area eaten by the insects. This visual observation was conductedtwice a week at three stations per plot, with three plants per station, from cotyledon to the four leafstage. During flowering, distribution and incidence of the insects were determined by three sweeps of a standard insect sweep net at two stations per plot, on five sampling dates. Identification and counting were done directly in the field. To assess the presence of *C. obstrictus* larvae (damage and emergence hole) 200 pods were randomly collected from each plot at the "green bean" stage (growth stage 5.1-5.2, Harper and Berkenkamp 1975). The number of seeds eaten per pod was noted for each pod with an emergence hole.The average plant population per plot was noted and the crop growth stage was monitored weekly according to the method of Harper and Berkenkamp (1975). The N content of the biomass was measured in the middle of flowering and on the harvest day. Straw and seed yields were measured by harvesting five rows in each plot.Harvests were conducted on August 28th (0 and 50 Kg N ha^{-1}) and September 1st (100 and 150 kg N ha^{-1})at St-Augustin and on September 7th (CT) and September 13th (ZT) at Normandin.

For each site, data from 2010 was subjected to an analysis of variance using PROC MIXED of SAS.Soil tillage and N sources and rates were considered as fixed effects, while replicates within site were random effects. All interactions among the three factors were included in the model for crop variables. Differences between means were considered significant at $P< 0.05$ using LSMEANS. In order to fulfil the assumptions of homogeneity of variance and normality of distribution, logarithmic ($\log_e x$) transformation wasperformed on several insect abundances data. However, only detransformed data concerning*P. striolata*,*C. obstrictus* and*M. viridescens*isdiscussed in this paper.

Results& Discussion

The spring of 2010 was particularly dry at both research stations (see Table 1.) and consequently, very low soil moisture levels did not permit a uniform emergence, especially at Normandin.Mean number of plants per linear meter was 11.5 ± 4.7 (S.E.)at Normandincompared to 25.6 ± 6.4 (S.E.) at St-Augustin.

Even though both *Phyllotretacruciferae* (Goeze) and *Phyllotretastriolata* (Fabricius) are present in Eastern Canada, only *P. striolata*was observed at both sites. Tansey et al. (2008) reported in Western Canada that*P. striolata* is less susceptible to the clothianidin (Prosper 400) seed treatments than *P. cruciferae*. This may explain such segregation between the two species.Thus, *P. striolata* damage to canola seedlings grown in CT was significantly greater than for plants grown in ZT at Normandin (F = 17.72; $P< 0.0001$) (Figure 1.) while it was not significantly different at St-Augustin. Other studies demonstrated that *Phyllotreta*sp. populations were usually lower in ZTplots than in plots tilled conventionally(Milbrath et al. 1995;Dosdall et al. 1999). *Phyllotreta*sp.generally prefers warm and dry conditions (Tahvanainen, 1972), which are more characteristic of CT systems.

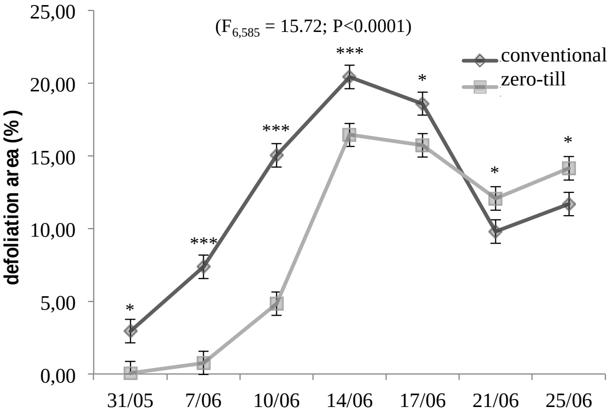

Figure 1. Mean defoliation area caused by *P. striolata* as a function of tillage (Normandin)

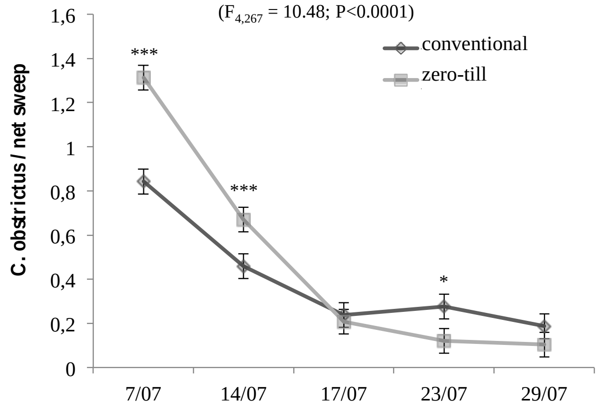

Figure 2. Abundance of *C. obstrictus* as a function of tillage (St-Augustin)

Tillage significantly affected *C. obstrictus* abundance (F = 10.48; P <0.0001) (Figure 2.). Theabundances of *C. obstrictus* were greater in the ZT plots than in the CT plots on July 7th(mean abundance of 1.3 and 0.8 by sweep net; respectively) and July 14th(mean abundance of 0.7 and 0.5 by sweep net; respectively). Tillage's impact on emergence was especially observed in the ZTplots for both sites. In dry soil condition such as in 2010, both the germination and the plant development were delayed in ZT plots. Moreover, canola plants under ZT regime did not benefit much from the first 20 Kg N ha^{-1}application which was not incorporated. As a result at St-Augustin for instance, most of the canola in ZT plots was on stage 4.2 while canola CT plots was on stage 4.3 of Harper and Berkenkamp (1975) on July 14th.At growth stage 4.2, many flowers are open and at growth stage 4.3, lower pods are starting to fill. In Western Canada, maximum *C. obstrictus* adult migration to springcanola was observed in the bud and flowering stages (Dosdall et al. 2004). It seems that such migration occurred at St-Augustin and that plants in the ZT plots were more suitable to *C. obstrictus* adults for the first two sampling dates. Note that the figure 2. suggests that 2010 sampling began too late to observe the beginning of the migration. We might have observed an earlier *C. obstrictus* population maximum in the CT plots that had reach the bud and flowering stages before the ZT plots. Such consideration should be taken care of in the summer 2011 experiment.

The number of seeds consumed per pod by *C. obstrictus* varied from 0 to 21 seeds, which represented between 0 and 80% of total seeds per pod. Dmoch (1965) reported thatin winter-rape,*C. obstrictus* larvae consume four to six seeds during three instars.Dosdall et al. (2004) demonstrated in spring canola that *C. obstrictus* development occurred more rapidly and successfully within the short-season. Such shortened feeding window may partially explain the greater seeds per pod consumed by *C. obstrictus.*

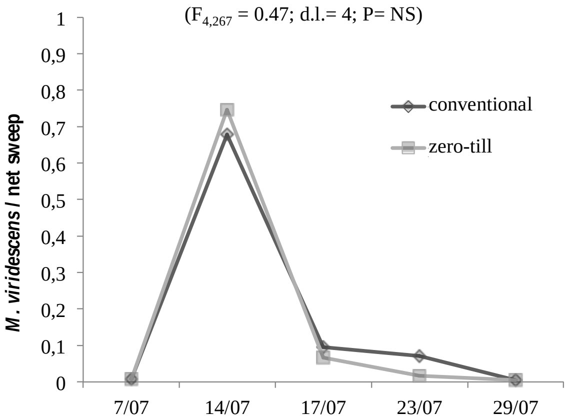

Figure 3. Abundance of *M. viridescens* as a function of tillage (St-Augustin)

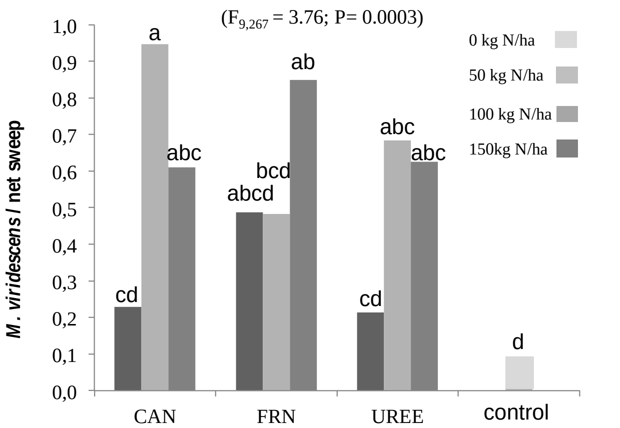

Figure 4. Abundance of *M. viridescens* (July 14th) as a function of N source & N rate (St-Augustin)

The insect abundances had no significant impact on seed and straw yield. The effects of N sources and N rates were not significant for both sites, except for *M. viridescens*, which was significantly affected by

N rates on one sample date (*F* = 3.76; *P* = 0.0003). This exclusively pollinivorous insect migrated toward the canola plots on a very punctual phase (observed on July 14th) and was most abundant in the fertilized canola plots compared to the control plots (Figure 3 and 4). Further investigation will be held in summer 2011.

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