Phytoprotection

Stork's bill (*Erodium cicutarium* (L.) L'Her. ex Ait) and hemp-nettle (*Galeopsis tetrahit* L.): a cautionary note for eastern Canada field crops

Un avertissement concernant l'érodium cicutaire (*Erodium cicutarium* (L.) L'Her. ex Ait) et l'ortie royale (*Galeopsis tetrahit* L.) dans les grandes cultures de l'est du Canada

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Article abstract

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Stork's bill (*Erodium cicutarium* (L.) L'Her. ex Ait) and hemp-nettle (*Galeopsis tetrahit* L.): a cautionary note for eastern Canada field crops

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Keywords: conservation tillage, *Erodium cicutarium*, *Galeopsis tetrahit*, hemp-nettle, no-till, redstem filaree, stork's bill, weed seedbank.

[Un avertissement concernant l'érodium cicutaire (*Erodium cicutarium* (L.) L'Her. ex Ait) et l'ortie royale (*Galeopsis tetrahit* L.) dans les grandes cultures de l'est du Canada]

L'érodium cicutaire a été observée pour la première fois en 2009, puis à nouveau en 2010, dans une étude sur la conservation des sols en place depuis 22 ans, à La Pocatière, Québec. En un an, l'espèce s'est répandue de deux à dix parcelles et la densité est passée de ≤ 12 plants m^{-2} en 2009 à 100-232 plants m^{-2} en 2010. L'érodium cicutaire, n'étant pas une mauvaise herbe d'importance agricole dans l'est canadien, devra être surveillée étroitement de façon à pouvoir intervenir rapidement et prévenir son expansion. La densité relativement élevée d'ortie royale dans le semis direct comparativement aux parcelles avec travail du sol en 2009 a été attribuée à une opération exceptionnelle de sarclage mécanique dans le semis direct, ce qui confirme la sensibilité de l'espèce au travail du sol.

Mots clés : banque de graines de mauvaises herbes, érodium cicutaire, *Erodium cicutarium*, *Galeopsis tetrahit*, ortie royale, pratiques de conservation des sols, semis direct.

A long-term study examining the effects of conservation tillage practices on a number of agrobiological variables has been ongoing at La Pocatière, Québec, since the autumn of 1987. Two weed species caught our attention in the summer of 2009 for different reasons: stork's bill (*Erodium cicutarium* (L.) L'Her. ex Ait), because of its unexpected presence, and hemp-nettle (*Galeopsis tetrahit* L.), because of its occurrence in no-till plots. Stork's bill (Geraniaceae) has an annual, winter annual, or biennial life cycle. Stork's bill will emerge under cool to moderate temperatures (5-20°C) and can form a persistent seedbank (Blackshaw 1992; Blackshaw and Harker 1998a). The occurrence and density of stork's bill has increased in western Canada, particularly in association with conservation tillage (Leeson *et al.* 2005), but it is still scarce as an agricultural weed in eastern Canada. However, two organic vegetable crop producers have recently reported its presence near Rimouski, Québec (Christiane Cossette, pers. comm.). Stork's bill can be a fierce competitor, causing near total yield loss in some crops such as dry bean (*Phaseolus vulgaris* L.) and pea (*Pisum sativa* L.) (Blackshaw and Harker 1998b).

Hemp-nettle (Labiatae, hetero-tetraploid hybrid: *G. pubescens x G. speciosa*) is an agricultural weed throughout Canada (Darbyshire 2003). Hemp-nettle

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has been identified as the most widespread and abundant species in spring cereals surveyed in New Brunswick (Thomas *et al.* 1994). Hemp-nettle frequency, field uniformity and density in western Canada have decreased between 1970 and 2000, likely because of the availability of more efficient herbicides and decrease in tillage (Leeson *et al.* 2005). Hemp-nettle is an annual species that emerges early in the spring (Légère and Deschênes 1989). Seeds germinate at lower temperatures (approx. 5-15°C) (O'Donovan and Sharma 1987), and hemp-nettle emergence is mainly associated with tillage (O'Donovan and Sharma 1987).

The objective of this short communication is to document a recent introduction of stork's bill at La Pocatière, Québec, and confirm the role of tillage in explaining hemp-nettle presence by comparing recent (2009-2010) and past (1988-2008) occurrences of these two species, using plant and seedbank data from a long-term conservation tillage study.

The study was conducted at the Centre de développement bioalimentaire du Québec, in La Pocatière, Québec (47°21'N, 70°02'W), on a Kamouraska clay (Orthic Humic Gleysol/fine, mixed, frigid Typic Humaquept; 10% sand, 30% silt, 60% clay in the surface horizon; pH = 5.9; organic matter = 45 g kg^{-1}; P = 94 kg ha^{-1}, Mehlich 3 extractable; K = 305 kg ha^{-1}). Tillage treatments, initiated in autumn 1987, were as follows: moldboard plow (MP) in the fall (15-18 cm), followed by spring secondary tillage; chisel plow (CP) in the fall (12-15 cm), followed by spring secondary tillage; and no-till (NT). Tilled (MP and CP) plots were plowed every other year in the first phase of the study (2-yr barley (*Hordeum vulgare* L.) – red clover (*Trifolium pratense* L.) rotation: 1987-1995), and every year thereafter. Agronomic practices, including cultivar, seeding rates and dates, herbicides and fertilizers, were selected according to soil and crop requirements, and provincial recommendations. A 4-yr crop rotation, initiated in 2007 and applied to all plots, consisted of barley underseeded with red clover (2007), red clover forage production (2008), silage corn (*Zea mais* L.) (2009), and soybean (*Glycine max* (L.) Merr.) (2010). Cropping system and tillage treatments were applied to plots according to a strip-split plot experimental design with four replicates. Cropping systems (organic, OR: using organic fertilizers and mechanical weed control; herbicide-free, HF: using mineral fertilizers and mechanical weed control; genetically modified, GM: using transgenic herbicide-resistant crops; and conventional, CV: using mineral fertilizers and herbicides) were assigned to the main plots, and tillage (MP, CP, NT) to subplots (5 m x 13 m).

In 2009, a stale seedbed was prepared in tilled plots (MP, CP) with a rigid-tooth harrow on 4 May and again on 26 May, just prior to seeding. Corn (glyphosate tolerant hybrid 'N11KGT' in CV, HF and GM systems; conventional hybrid 'N14DY' in the OR system) was seeded on 28 May at 82,300 seed ha^{-1} in 76-cm rows. Mechanical weed control was conducted on 18 June at the three-leaf stage of corn with a single pass of rigid-tooth light harrow (Hatzenbichler™) in the MP-HF and MP-OR systems, and a single pass of Hiniker™ cultivator (sweeps mounted on curved shanks) in the CP-OR, CP-HF and, exceptionally, in NT-OR and NT-HF plots; it was the first tillage operation conducted in these NT plots in 22 yr. In 2010, a pre-seeding glyphosate treatment at 750 g a.e. ha^{-1} was applied on 1 May to all cropping systems except OR. A stale seedbed was prepared in tilled plots (MP, CP) with a rigid-tooth harrow on 18 May and then again on 27 May, just prior to seeding. Soybean (glyphosate-tolerant 'Apollo RR' in CV, HF and GM systems; conventional 'Tundra' in the OR system) was seeded on 28 May at 603,000 seed ha^{-1} in 18-cm rows. A single pass of rigid-tooth light harrow (Hatzenbichler™) was conducted on 30 June at the second trifoliate leaf stage of soybean in HF and OR systems with MP and CP tillage.

Weed communities were sampled after in-crop herbicide applications from 1989-1992. Pre-herbicide weed density was measured from 2006 onwards. Weed communities in corn (2009) and soybean (2010) were sampled prior to (June) and after (July) in-crop weed control in two quadrats (2009: 50 cm x 75 cm; 2010: 50 cm x 50 cm) per plot. The 2009-2010 data for stork's bill and hemp-nettle were compared with available plant population and seedbank data from previous years (1989-2008). Weed seedbank data collected in April 1993, May 2006 and in the autumn of 1989 to 1992 were examined for the presence of stork's bill and hemp-nettle. The spatial distribution of both species across the site precluded the use of statistics. Available treatment means and SE will be used for the purpose of this paper.

Stork's bill was presumed to be absent from the site from 1987 to 2008 as there is no record of the species from either plant or seedbank assessments or from casual visual observations. In 2009, stork's bill was found in one NT (12 plants m^{-2}) and two CP (2 plants m^{-2}) plots. Stork's bill was also observed in the alleys between plots in the two replicates where red clover had been reseeded in spring 2008 because of poor establishment in the previous year. In 2010, the species was found in the same two replicates and it had spread to 10 plots. Stork's bill was absent from CV and GM systems with MP and NT, but populations ranged between 100 and 232 plants m^{-2} in HF and OR systems with CP tillage.

This is the first observation for stork's bill at this site, for both aboveground and seedbank. The presence of this species coincides with areas where red clover was re-seeded in spring 2008 to improve the forage stand. Machinery used in the forage plots had been used previously at the Université Laval experimental farm in St-Augustin-de-Desmaures, QC, where stork's bill has been present since the early 2000s (Susanne Buhler, pers. comm.); stork's bill may thus have been introduced at our site with this machinery. Alternatively, stork's bill was possibly introduced as a contaminant in the red clover seed lot. Stork's bill seed is apparently difficult to clean out of small-seeded crops. Some red clover seed is produced in western Canada where stork's bill can be a prevalent weed. Unfortunately, we were unable to trace the origin of the seed lot used in our study to check for potential contamination. The odds of stork's bill becoming a weed of field crops in eastern Canada could be high, especially with increasing adoption of conservation tillage and low input cropping systems. Also, stork's bill germinates and grows better under cool humid conditions (Blackshaw 1992; Blackshaw and Entz 1995), which are typical of eastern Canada. Stork's bill may not yet be an important agricultural weed in eastern Canada, but it is present in all provinces (Darbyshire 2003). In this study, stork's bill populations increased 10-fold within 2 yr. Stork's bill seedbanks can also build up rapidly. Four yr after the introduction of the species at an experimental site in Alberta, stork's bill populations had returned 12,000 seeds m^{-2} in thin wheat stands and also produced seedbanks of 2,600 seeds m^{-2} in the more competitive dense wheat stands (Blackshaw *et al.* 2000). The presence of stork's bill in eastern Canadian field crops should thus be monitored closely and acted upon quickly so as to prevent its establishment and spread.

In the early years of the study (1989-1996), average hemp-nettle density (post in-crop weed control) was generally greater in tilled treatments and did not exceed 12 plants m^{-2} (Fig. 1). In 2009, hemp-nettle density (prior to in-crop weed control) reached 42 plants m^{-2} in NT treatments compared with less than 1 plant m^{-2} in MP and CP treatments. Conversely, in 2010, hemp-nettle density in MP and CP (36 and 33 plants m^{-2}, respectively) was nearly four times greater than in NT (9 plants m^{-2}) (Fig. 1). Hemp-nettle seedbanks ranged between 1 and 20 seeds m^{-2} between 1989 and 1992 across tillage treatments. By 2006, hemp-nettle seedbank density was small, but slightly greater in MP (9 seeds m^{-2}) than in CP or NT (4 and 3 seeds m^{-2}) (Fig. 1). The large variability (SE ≥ mean) in the seedbank data indicates the possible presence of hemp-nettle "hot spots" across the site. Indeed, plots in which there was high hemp-nettle density in 2009 (mainly NT-GM and NT-HF treatments) were those where the largest seedbanks had been recorded in 1992 (up to 393 seed m^{-2}) (results not shown).

The unexpected prevalence of hemp-nettle in NT compared with tilled treatments in 2009 was attributed to the exceptional use of a cultivator for weed control in HF and ORG cropping systems where no herbicides could be used. Whether the 2009 populations originated from persistent seedbanks or recent seed input is unclear. In Europe, hemp-nettle seedbanks are considered persistent (1-5 yr) (Thompson *et al.* 1997). However, in England, hemp-nettle seed density in the soil declined rapidly over 5 yr, but it was not monitored further because of potential seed input from uncontrolled residual plants (Lutman *et al.* 2002). In Alaska, hemp-nettle seeds buried 2 and 15 cm deep had lost all viability 5 yr after burial (Conn and Werdin-Pfisterer 2010). Conversely, hemp-nettle populations of up to 1,000 seedlings m^{-2} were observed after a 15-yr-old pasture was plowed in eastern Québec (Légère 1987), suggesting a persistent seedbank. Many factors could explain these discrepancies, including genetic variation between biotypes, environmental conditions during and after seed formation affecting dormancy, soil conditions determining the quality of microsites, and agronomic practices.

These observations for stork's bill and hemp-nettle confirm the importance of preventing weed seed production to curtail the establishment of newly introduced weed species or re-infestations of established species. In the case of stork's bill, early and rapid action will be needed to prevent the species from becoming a weed of agricultural importance in eastern Canada.

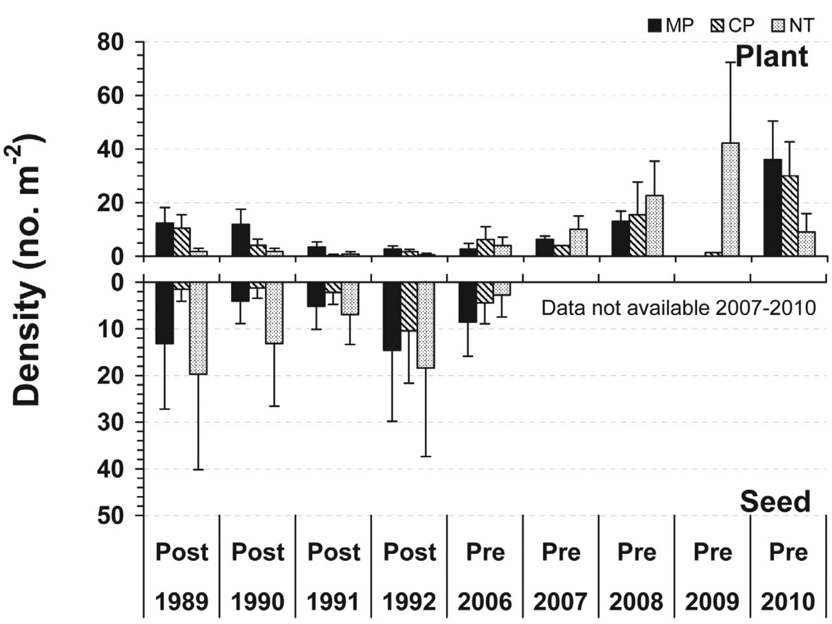

Figure 1. Effects of tillage (MP: moldboard plow; CP: chisel plow; NT: no-till) on hemp-nettle mean plant density (post: measured after in-crop weed control in 1989-1992; pre: measured prior to in-crop weed control in 2006-2010) and soil seed density (measured in autumn 1989-1992 and spring 2006; seedbank data not available for 2007-2010) at La Pocatière, Québec. (For more details, see Légère *et al.* 2005, 2011).

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