Volunteer canola (*B. napus*) in western Canada

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Introduction

   In western Canada, survey and small plot research has shown that volunteer canola persists for at least four years in rotation (Derksen at al. 1999; Thomas et al. 1999). It is not clear whether this is due to persistence of the seedbank additions during harvest or the result of replenishment of the seedbank by subsequent volunteers. We are examining the life cycle of volunteer canola beginning with the seedbank additions incurred during harvest and as well as a focus on the seedbank ecology of this species in western Canada.

   Research in Europe has shown that *B. napus* can be readily induced into secondary dormancy by a combination of darkness and moisture stress (Pekrun, 1994). Nonetheless, field studies have revealed that only a small proportion of seeds persist via secondary dormancy in Europe (Pekrun et al. 1998).

   Canadian *B. napus* genotypes differ in their potential for induction into secondary dormancy using a laboratory assay. While some genotypes consistently exhibit low potential for the induction into secondary dormancy, others consistently exhibit high potential for the induction into secondary dormancy. High temperatures are perhaps the most important contributing factor to the induction of secondary dormancy, while low temperatures rapidly remove secondary dormancy. These observations suggest the seed ecology of a typical summer-annual weed. Furthermore, observations in a field experiment in 2000 revealed that volunteer canola germination was limited to the early portion of the growing season. Spring seedbank evaluations indicated far greater seed viability than was reflected by field emergence. It is was not clear if the seeds that did not emerge lost viability or were induced into secondary dormancy as our lab results would suggest. A more detailed field experiment examining the persistence of *B. napus* and induction into secondary dormancy was initiated.

Materials and methods
Seedbank addition study
   In the fall of 1999 and 2000, a total of 35 fields from 15 producers where surveyed immediately after harvest. Using a vacuum cleaner, a series of 25 x 25 cm^2 quadrats where sampled along three transects between randomly chosen adjacent windrows. Canola seeds were separated from the soil and residue, weighed and tested for viability. Thousand kernel weights were also determined for each sample.

Dormancy cycle study
   Two *B. napus* cultivars with the most divergent potential for the development of secondary dormancy were chosen for this field experiment. In the fall of 2000, a series of plastic pots were buried at two locations with differing soil type near Saskatoon, Sk. Two hundred seeds of each *B. napus* cultivar (app. 10,200 seeds m^{-2}) were placed at depths of 1 and 10 cm in plastic pots that were buried in four zero tillage and four conventional tillage plots. At various times throughout

the year, one pot per repetition was exhumed from each treatment. The pots were placed into a growth cabinet at a constant temperature of 15C and irrigated. Germination of canola was observed for two weeks. Immediately following germination, the remaining apparently viable seeds were washed from the pots, placed in petri dishes containing moistened filter paper and stratified in a refrigerator for 7 days. After stratification, the petri dishes were again placed in the 15C cabinet and germination was monitored for a further 2 weeks. More than 98% of the washed out seeds germinated after stratification and were considered dormant. Percent dormancy was determined in relation to the original seedbank additions. Other parameters measured included soil temperatures throughout the year as well as gravimetric soil moisture contents.

Results and discussion
Seedbank additions study
  In the seedbank addition study, average seed viability was 82%, indicating that on average 3000 viable seed m^{-2} (table 1) are added to the volunteer canola seedbank during the harvest process. These results were rather consistent between years and no correlation between yield was found. Seedbank additions were quite variable and ranged from fewer than 2,000 seeds m^{-2} (table 1) to greater than 10,000 seeds m^{-2} (data not shown). A producer specific effect on seedbank additions was observed suggesting that more careful harvest management may significantly reduce seedbank inputs on some farms (table 2). Nevertheless, with seedbank additions of this magnitude, even low persistence rates may potentially result in a recurring weed problem for several years.

Field dormancy study
  Low precipitation throughout the 2001 growing season resulted in low in field emergence of volunteer *B. napus*. Similar to previous observations, no field germination of volunteer canola was observed after late May. Germination from the shallow depths was readily visible in the field and in the germination cabinet. In the growth cabinet, visible germination decreased to zero in all treatments by the last exhumation date (data not shown). In the field, no seedlings emerged from the 10 cm burial depth while only a few seedlings emerged from that depth during the two week germination period in the cabinet (data not shown). Figure 1 shows the percentage of dormant seeds that germinated post-stratification after washing from the soil. Within exhumation date, secondary dormancy of volunteer canola was strongly influenced by location (soil type), genotype and burial depth (Fig. 1). No differences among tillage systems were observed (Fig. 1). This was primarily due to few observed differences in soil moisture at the exhumation dates (data not shown).
  At both locations, little secondary dormancy was observed at the shallow (1 cm) burial depth (Fig.1). An interaction in the development of secondary dormancy between cultivar, burial depth and location was observed within exhumation dates beginning in June and for the remainder of the year (Fig. 1). The genotype with high potential for the development of secondary dormancy (LG 3295) exhibited significantly higher levels of secondary dormancy at the 10 cm burial depth in a clay soil (Kernen) than in a sandy soil (Dundurn). We have observed a similar persistence pattern in a second experiment at the same locations. At all locations and burial depths, the genotype with low potential for the development of secondary dormancy (Option 501) exhibited low levels of secondary dormancy at all exhumation dates, suggesting low potential for persistence. LG 3295, on the other hand, exhibited a general increase in secondary dormancy as mean soil temperatures increased at the Kernen location. The increase in

secondary dormancy as a function of temperature corresponds well to our previous laboratory findings. Mean soil temperatures for 30 days prior to each exhumation date under conventional tillage were -0.03C (+/- 1.02 C), 7.92C (+/- 4.33C), 14.86C (+/- 1.79C), and 19.54C (+/- 1.71C) for mid-April, -May, -June, and -September, respectively. Our laboratory experiments have indicated that induction into secondary dormancy of LG 3295 is greatest at temperatures between 10-20C, while a short exposure to low temperatures results in removal of secondary dormancy.

Summary

 Seedbank additions as a result of harvest losses are quite variable across producers in western Canada and may be greater than 7,000 seeds m^{-2}. Initial findings from the seedbank ecology experiment indicate that soil type, genotype and burial depth strongly influence the development of secondary dormancy in *B. napus*. Our results suggest that certain spring *B. napus* genotypes may exhibit an annual dormancy cycle when buried. This may influence the seasonal germination behaviour and in conjunction with the relatively high seedbank additions during the harvest process may aid the persistence of the species. The reasons for the observed differences in secondary dormancy in LG 3295 caused by the contrasting soil types are currently not clear.

References

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Table 1. Total yield, yield loss, percent yield loss, thousand seed weight, and seedbank addition of *Brassica napus* during on-farm harvest as influenced year. Standard errors are indicated in parentheses.

Year	Yield	Yield loss		1000 seed weight	Seedbank add.
	kg ha^{-1}	kg ha^{-1}	%	g	seeds m^{-2}
1999	1980 (131)	110 (16)	5.9 (0.8)	3.15 (0.07)	3570 (518)
2000	1890 (115)	106 (14)	5.6 (0.7)	2.83 (0.07)	3610 (473)
LSD$_{0.05}$	n.s.	n.s.	n.s.	0.20	n.s.
Mean	1930 (123)	107 (15)	5.8 (0.8)		3590 (496)

Table 2. Yield loss and seedbank additions summarized by producers for which more than one field-year of data was available. Standard errors are indicated in parentheses. Means followed by different letters are significantly different as determined by LSD$_{0.05}$ means separation.

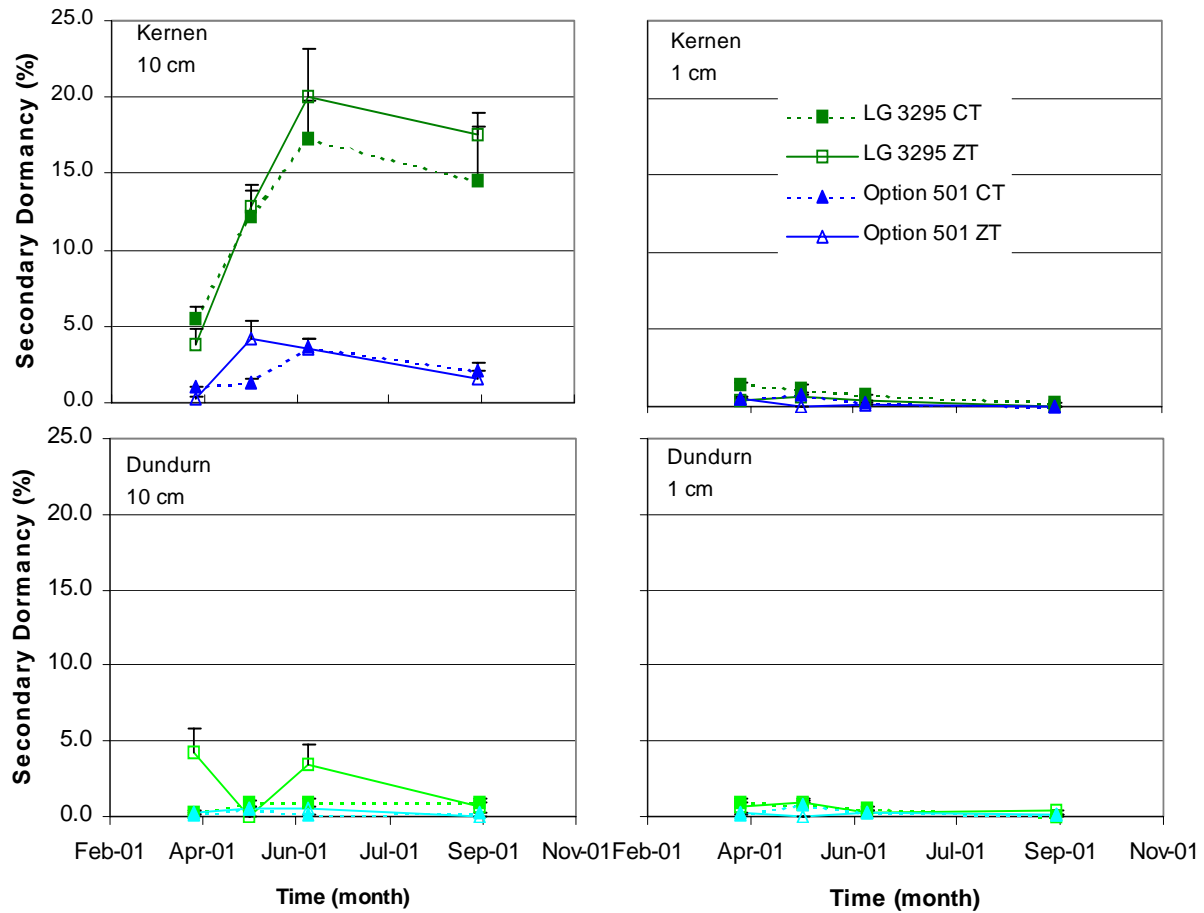| Producer	Yield loss		Seedbank addition
	kg ha^{-1}	%	seeds m^{-2}
1	146 (29) bc	9.6 (1.7) b	5250 (994) bc
2	107 (29) ab	4.9 (1.7) a	3760 (994) ab
3	44 (23) a	3.5 (1.4) a	1530 (811) a
4	83 (20) ab	3.3 (1.2) a	2660 (703) ab
5	97 (28) ab	4.3 (1.7) a	3110 (994) ab
6	125 (23) b	6.8 (1.4) ab	4300 (811) b
7	134 (28) b	6.9 (1.7) ab	4480 (994) bc
8	78 (20) ab	5.4 (1.2) a	2580 (703) ab
9	73 (20) ab	3.3 (1.2) a	2430 (703) ab
10	226 (30) c	9.9 (1.7) b	7130 (994) c

Figure 1. Secondary dormancy in two *B. napus* cultivars over time as affected by soil type and burial depth in conventional (CT) and zero-tillage (ZT). Standard errors of the mean are indicated.