Evaluating the Average Seedbank Addition of Canola in Producers' Fields

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Abstract

Seed shatter in canola leads to a considerable yield loss and the dispersal of canola seed into the seedbank. The volunteer plants can then create a weed problem in the subsequent crops and result in crop yield loss. In 2010 a study was conducted to measure the harvest losses of canola in producers' fields. A total of 26 fields were surveyed within 150 km radius from Saskatoon, SK. Out of these fields, 3 swathed and 3 direct combined fields from Kernen Crop Research Farm were included to compare the amount and time of seed loss in both harvesting methods. Sampling was done within 3 weeks of harvesting. Transects were laid at three random locations in each field from the center of one swath to the center of the adjacent swath. Six 0.25 m^2 quadrats were kept in each transect at 1m interval. Plant counts were taken in each quadrat before sampling and were included in the total seed loss. Then the remaining crop residue, shattered seeds and some surface soil were removed from each quadrat using Ultra Shop Vacuum Cleaner. The bulked sample of each transect was air dried and cleaning was done using Carter Dockage Tester with different Sieve combinations. Finally the weight of pure seed and thousand seed weight were measured to calculate the amount of seed loss per unit area. The average seed loss was found to be 135.5 kg ha^{-1}, which is equivalent to 5.8 % of the total yield and it resulted in seedbank addition of 4400 seeds m^{-2}. Yield loss among producers ranged from 2.2 to 13.6 % (13 to 70 times the normal seeding rate). An average of 379 seeds m^{-2} were germinated (ranged from 6 to 2224 seeds m^{-2}) within 3 weeks of harvesting. Direct combining resulted in higher seed loss than swathing. Both natural dehiscence of pods and seed loss from combining contributed for the buildup of canola seedbank.

Introduction

Canola is an important oil crop grown in western Canada. The current canola market is comprised of three species namely: *B. rapa* or Polish canola, *B. napus* or Argentine canola, and *B. juncea* or canola quality brown mustard (Canola council of Canada 2010). Canola is a relatively young crop and possesses a number of feral plant characteristics (Gruber et al. 2004). One of these characteristics is the presence of high seed loss in canola either from natural dehiscence of pods at maturity or crop disturbance by harvesting machinery (Price et al. 1996;

Morgan et al. 1998). When the seeds reach maturity, losses due to shattering can reach up to 10% of the seed yield (Devos et al. 2005).

Besides the considerable amount of yield loss due to shattering, the volunteer canola (plants arising from seeds left in the field after crop harvest) are creating weed problem in the subsequent crops competing for nutrients, water and space. Apart from their weedy characteristics, volunteer canola may cause genetic contamination through pollen transfer to the subsequent crops especially when the following crop is a different cultivar of canola (Morgan et al. 1998). In western Canada, volunteer canola is ranked as the 12th most abundant weeds (Leeson et al. 2005). With the increasing acreages of herbicide resistant canola in western Canada, there have been increasing concerns about the persistence of volunteers (Gulden 2007).

Seed losses during harvesting and seed contamination are initial sources of canola seed to the soil seed bank (Gulden et al. 2003a). In ideal harvest conditions yield loss ranges from 2 to 5% of the total yield where as losses of 20-25% of the total yield are common under most circumstances, but in seasons when adverse weather conditions delayed harvesting seed loss can reach as high as 50% of the total yield (Price et.al. 1996). Seed loss up to 25% of the total yield has been reported in good weather conditions when harvest operations are late (Bruce et al. 2001). Given a potential seed yield of 2000-4000 kg ha^{-1} and a 1000 kernel weight of 4-5 g, a yield loss of 2 to 5% means a loss of 1000-5000 seeds m^{-2}, which is 10 to 35 times more than the sowing rates of 80-150 seeds m^{-2} (Devos et al. 2005). In Saskatchewan, Gulden et al. (2003b) reported that the mean seed loss was found to be 107 kg ha^{-1} or 5.9% of the crop seed yield which is approximately equivalent to 3,000 viable seeds m^{-2}.

Gulden et al. (2003) surveyed a total of 16 and 19 canola fields within 150 km radius from Saskatoon in 1999 and 2000 respectively and established a baseline to measure the average seedbank addition of canola in western Canada. But he could not determine the factors that contributed to harvest losses in canola since the sample size was small. This time we are doing a wider survey that includes Alberta, Manitoba and Saskatchewan with the intention to see regional differences, if any, in harvest loss in canola. Moreover after 10 years of improving canola varieties it would also be interesting to see if the harvest losses as a proportion of yield have changed.

Objective

To determine the average seedbank addition of canola in producers' fields

Materials and Methods

Sample collection

In 2010, a total of 26 fields were surveyed within 150 km radius from Saskatoon, SK. Out of these, 3 direct combined and 3 swathed fields from Kernen Crop Research Farm, University of Saskatchewan, were included to compare the amount and the timing of seed loss from the two harvesting methods. In these 6 fields seed collecting trays (1.2 m X 0.11 m) were used to measure shattered seed at different times. In the swathed fields, trays were kept under the swath immediately after swathing. Then they were emptied before and after combining the swath to measure seed loss from natural shattering and combining. Similarly, in direct combined fields trays were kept under the plant canopy at early stage of pod filling and they were emptied before and after combining. All fields were sampled within 3 weeks of combining. Due to excessive rainfall during summer there were considerable germination of canola seeds and plant counts were done before taking the sample. Canola was last grown on all sampled fields 2 or more years before the canola crop that was sampled and this minimizes the chances of sampling seeds from the previous canola crop. For each field, data concerning the agronomic and harvest specific information were collected from producers using a survey questionnaire. The information included crop seed yield, cultivar grown, years since the last canola crop, swathing and combining speeds, combine type and perceived time of windrowing relative to crop maturity.

In each field samples were collected from three random transects which were laid from the center of one windrow to the center of the next windrow. Using Ultra Shop Vacuum Cleaner, all the remaining crop residue, shattered seeds, and some surface soil were removed from six 0.25 m^2 quadrats which were kept at 1m interval along each transect. The bulked sample from the 6 quadrats was kept in a cloth bag, air dried, and stored for cleaning.

Seed Separation

The bulked samples were passed through a Dockage tester (CEA. Simon-Day LTD.) The samples were passed through 9/64 X 11/16 inch oblong sieve on top and another 8/64 inch round sieve in the middle which were able to separate out the large clods and chaff allowing the passage of canola seeds and fine chaff and soil. This combination of sieve size was selected after testing that all seeds can pass through while separating the clods and larger chaff. The larger clods were crushed using belt thresher and again the crushed sample passed through the dockage tester in order to separate out the seeds which might have been present inside the clods. The sample passed through the dockage tester were again hand sieved using 3/64 X 5/16 inch oblong sieve to separate out the fine soil from the remaining sample. At this point, 50 seeds were picked by hand from each sample for later germination test and the remaining samples were wet sieved to wash out the remaining soil. After that samples were kept in a drying room for 24 hours at a temperature of 40 ^{0}C. After drying, the remaining chaff was blown and the samples were rolled down a smooth inclined surface to separate the seeds from stones. Finally cleaning of small round stones and weed seeds was done by hand and the weight of pure seed was taken and used to determine the number of seeds lost per unit area.

Germination assay

From each sample, 50 seeds were kept in 9 cm diameter plastic Petri dish on 2 layers of filter paper and 8 ml of distilled water to examine their viability. Then they were kept in a growth chamber at 20 ^{0}C. Counts of germinated seeds were taken every other day. After two weeks in the germination cabinet the remaining non germinated seeds were stratified at a temperature of 2 to 4 ^{0}C for 5 days. After that they were returned back to 20 ^{0}C and allowed to germinate for one more week. Seeds which did not germinate after one week were examined for viability using 1% solution of 2,3,5-triphenyltetrazolium chloride.

Result and Discussion

The average seed loss was found to be 135.5 kg ha^{-1}, which is equivalent to 5.8 % of the total yield and it resulted in seedbank addition of 4400 viable seeds m^{-2}. The percent yield loss is similar to what Gulden et al. (2003) reported but the number of viable seeds that entered the soil seed bank increased from 3000 seeds m^{-2} to 4400 seeds m^{-2} mainly because of the increase in yield of the current canola cultivars. Yield loss among producers ranged from 2.2 to 13.6 % of the total yield (13 to 70 times the normal seeding rate). From the plant counts, an average of 379 seeds m^{-2} germinated but its range was from 6 to 2243 plants per m^{-2}. These plant counts were done within three weeks of harvesting and probably germination of seeds would increase with time. High fall seed germination is important to reduce canola seedbank as the seedlings will be killed by the winter freeze. Germination of shattered seeds depends on the presence of post harvest rainfall. In 2010 the post harvest rainfall was very high and resulted in the germination of significant number of seeds. But in case of dry year there will be less germination and results in more seedbank addition. The highest germination we counted was almost equivalent to half of the average seeds which entered the soil seedbank. This shows that there are still a considerable number of viable seeds remaining in the soil and that will result in the presence of volunteer canola many years after harvesting of the canola crop.

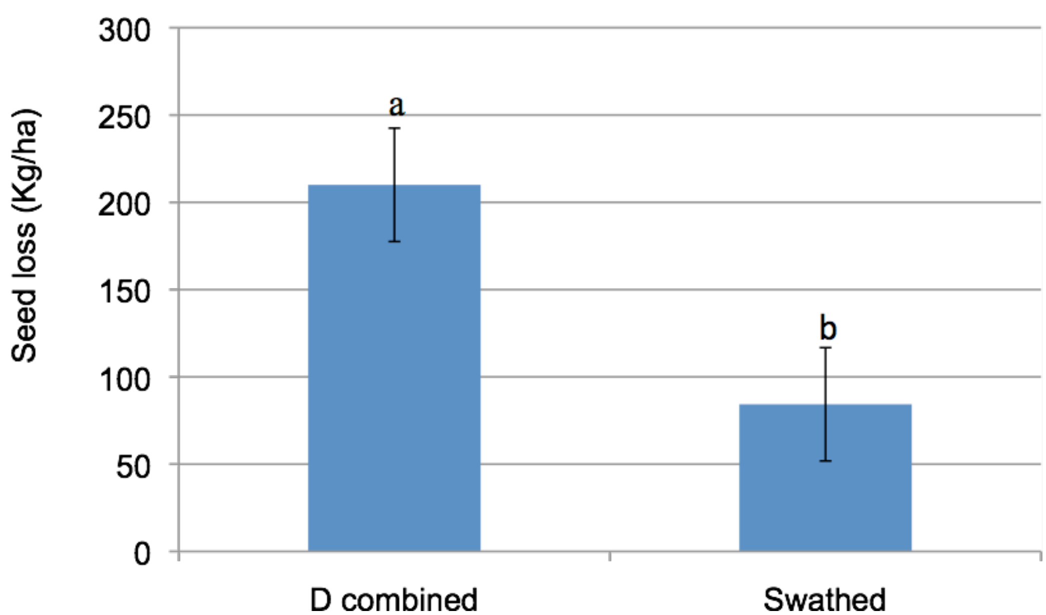

Figure 1. Comparison of seed loss by harvest method

Direct combining of canola resulted in significantly higher seed loss than swathing (Fig. 1) in 2010. This is the result that we expected to see in a year like last year. But from the small number of fields we sampled to compare the harvest loss in the two harvesting methods we cannot conclude that direct combining is extremely bad. This research needs to be repeated and more fields should be assessed before reaching a final conclusion.

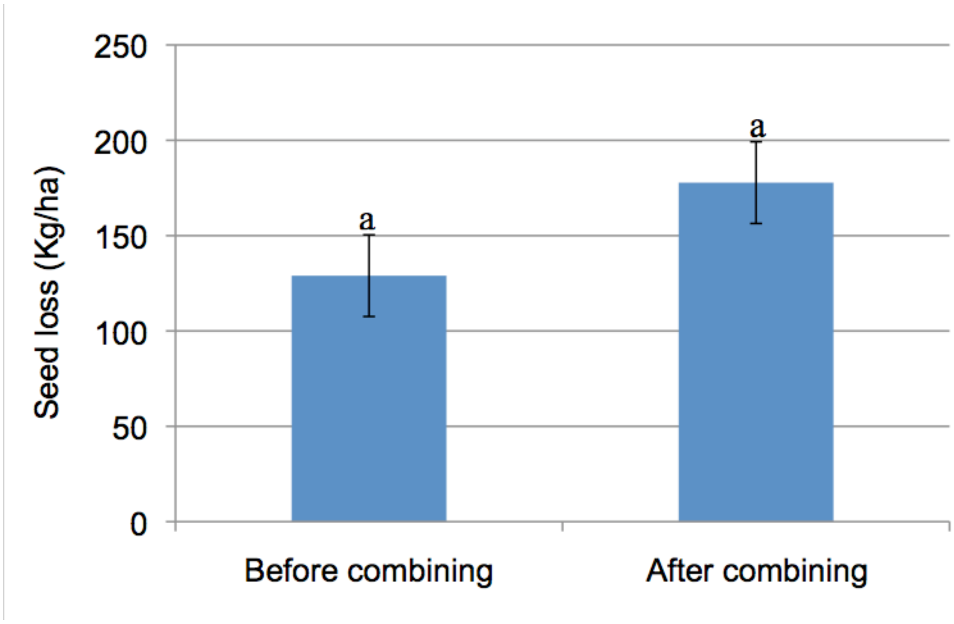

Figure 2. Comparison of timing of seed loss in swathed fields

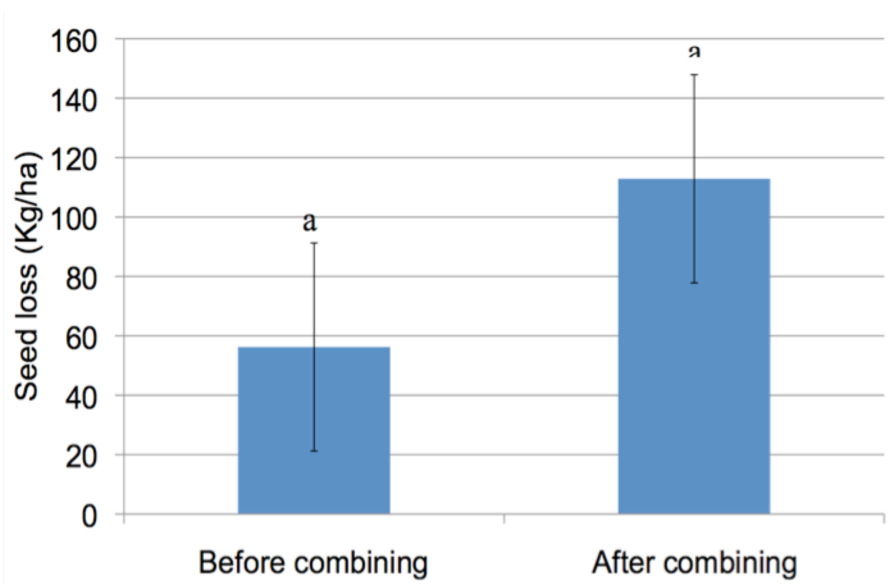

Figure 3. Comparison of timing of seed loss in direct combined fields

In both swathed and direct combined fields there was no significant difference in the amount of seed loss before and after combining of the swath and standing crop respectively. This shows that both natural dehiscence of pods and seed loss from the combine equally contribute for the canola seedbank. The large error bars in the direct combined fields show a large range in the observed values and that could be the reason for the non-significant result.

Conclusion

Seed losses at or prior to harvest result in the buildup of canola seedbank. The first year result showed that seed loss in canola is many times higher than the normal seeding rate. From the survey questionnaires it was possible to see that the varietal differences and the difference in the combine types and their settings are the major factors for the difference in canola seed shattering loss among producers. Also both seed loss from the natural dehiscence of pods and disturbance by the harvesting machinery are equally important for the buildup of canola seedbank. At this point, swathing is a better option for reducing seed shattering loss than direct combining. This result will be repeated in 2011 before the final results will be published.

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