Gene Flow and Accumulation Between Herbicide Resistant Canola (*Brassica napus* L.) and a Related Weed Species (*B. rapa* L.)

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December 2002

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ABSTRACT

Herbicide-resistant canola (*Brassica napus* L.) cultivars have been developed using both conventional breeding and recombinant DNA techniques, to aid weed management in canola. Concerns have been expressed that these herbicide resistance traits will escape into the ecosystem through hybridization between canola and related weed species, hence making the weed species more invasive. This study investigates the potential for sexual transfer of herbicide resistance traits from herbicide-resistant canola crops to other canola crops, and to a closely related weed species, field mustard (*B. rapa* L.), while also examining the possibility of producing viable canola x weed hybrids with multiple herbicide resistance traits.

Three forms of herbicide resistance were used in this study: glyphosate (Roundup Ultra®), glufosinate (Liberty®), and imazamox (Beyond®). Field mustard plots were planted adjacent to herbicide-resistant canola to encourage cross-pollination between the two species. At harvest, seed from field mustard plots was collected by hand-threshing, and was planted in flats in the greenhouse and in a field trial and screened for resistance to herbicides (corresponding to the resistance of the herbicide-resistant canola planted adjacent in the field). After the first year of the study, herbicide resistance for glyphosate was found in 3.0% of canola x field mustard hybrids, glufosinate resistance in 5.3%, and imazamox resistance in 6.0% of hybrids in greenhouse screenings. In field screening, 7.6% of hybrids were resistant to glyphosate, with 5.9% and 17.2% resistant to glufosinate and imazamox, respectively. All putative canola x field mustard hybrids showed morphological characteristics of canola and field mustard. Fifteen percent of resistant hybrids were self-compatible. A similar study found 13.3%, 1.8%, and 0.4%

hybridization rate between glyphosate, glufosinate, and imazamox-resistant canola cultivars and a herbicide-susceptible canola cultivar (Sunrise).

Field mustard hybrids having resistance to a single herbicide were backcrossed to canola resistant to a second herbicide in the field. At the 4-6 leaf stage, plots were sprayed with herbicide that corresponded to the canola that was planted adjacent in the first year of study, and plants resistant to herbicide remained to potentially cross-pollinate with canola resistant to the second herbicide. At maturity, seed from surviving plants was hand-threshed and screened for resistance to two herbicides in the greenhouse and the field. Field and greenhouse screening showed average resistance to two herbicides was 11.9% and 3.1%, respectively. Field mustard hybrids resistant to two herbicides were backcrossed to canola resistant to the third herbicide, and seed was screened for resistance in the greenhouse. Backcrossing dual resistant hybrids to canola resistant to a third herbicide resulted in 2.8% of plants screened resistant to all three herbicides. Backcrossing dual resistant hybrids to a hybrid of a third herbicide resistance hybrid caused triple-herbicide resistance at a rate of 0.3%.

The total number of chromosomes in single and dual herbicide resistant canola x field mustard hybrids was investigated through meiotic chromosome counts. Overall, dual herbicide resistant hybrids (BC_1 canola) had higher numbers of chromosomes per cell than single resistant hybrids. This suggests that recurrent backcrossing to canola will result in crop x weed plants which have a higher canola chromosome compliment that the initial hybrids. This being the case, backcrossing to canola with different transgenes will encourage transgene stacking in a weedy background very similar to the original canola parents.

Self-compatibility and cross-compatibility influence frequency of hybridization and gene stacking between hybrids, and the genetic stability of canola pollen provides means to confer herbicide resistance traits more readily to offspring. Based on the results of this study, multiple resistance to herbicides with different modes of action is a possibility in canola x field mustard hybrids. Survival in the ecosystem is dependent upon plant self-compatibility, and whether pollen from an outside source is available. Plants that are cross-compatible are more likely to facilitate gene stacking, while self-compatible plants are more likely to discourage gene stacking, but may still contribute to future occurrences of herbicide-resistant weeds.