GOVERNMENT

ASSESSING THE EFFECT OF ALLELOPATHIC COVER CROPS ON WEEDS

Allelopathy is the direct or indirect impact on plant individuals, whether they belong or not to the same species. Established as substances composed of secondary metabolites, allelopathy can a) affect growth and yield of another plant and b) develop autotoxicity, where plant individuals' secrete chemicals that prevent propagation and development of seedlings of same species growth.

Allelopathy can be used as a strategic tool to mitigate chemical weed management. Residues of allelopathic cover crops not only provide benefits to the soil but also help to reduce weed populations during their growth and likely for the cash crops seeded in the season thereafter.

This project was divided into two years. The first year, four crops where chosen based on their allelopathic properties, availability and popularity among growers. Crops such as rye (Secale cereale L.), annual ryegrass (Lolium multiflorum L.), hairy vetch (Vicia villosa L.) and sunflower (Helianthus annuus L) have been shown to limit or reduce the growth of other plant species. In this experiment weeds were surveyed every two weeks (sixteen weeks total) after cover crop mix seeding to observe if allelopathic effects changed according to cover crop species or cover crop mixes. At the end of the season, plots were either roller-crimped or incorporated. The following growing season (second year), canola, field pea, wheat were sown perpendicular to the direction of these plots to observe if weed populations are still suppressed by the allelopathic effects of the cover crops and their mixes. A control plot is included where no crop is sown. Further, it was also assessed whether roller-crimping and incorporation impact weed suppression along with allelopathy.

CASH CROP SEEDING AND HARVEST (SECOND YEAR-2022)

Canola and unseeded split plots previously sown to annual ryegrass and plots seeded to combinations of annual ryegrass with hairy vetch, wheat split plots previously seeded to rye, sunflower and its combination, and pea split plots previously seeded to sunflower and mixes of rye with hairy vetch reported the lowest number of weed species compared to pea split plots previously seeded to mixes of annual ryegrass and sunflower (P=0.0297). As such, less weed individuals were found in areas seeded to rye compared to areas sown to mixes of sunflower with hairy vetch (P=P=0.0142).

Cover crop termination method had no impact on weed species and number (P=0.4493). Most of the impact on weeds can be attributed to the cover crop and subsequently to the cash crop seeded the following year. Rye has been shown to be extremely powerful in deterring other plant species. Previous literature does indicate that rye can reduce the presence of other weeds and even encourage the growth of some crops such as sunflower. This explains why sunflower with rye mixes reported some of the lowest numbers of species and number of individuals. Likewise, annual ryegrass produces copious biomass that smothers other weeds seedlings and prevents them from gathering sunlight. Moreover, presence of mixes rather than single cover crops was more effective in decreasing weed species and number. However, this was dependent on the species involved in the cover crop mix. This is congruent with results found in mixes of rye with sunflower and annual ryegrass with hairy vetch compared to mixes of sunflower with either annual ryegrass or hairy vetch.

Among all cash crops, canola (P=0.0436) was most affected by the presence of cover crop species previously seeded. Results showed that yield was greater from canola subsequently seeded to annual ryegrass, mixes of annual ryegrass and hairy vetch and sunflower compared to mixes of sunflower and hairy vetch. It is possible there might be an antagonistic effect from these three species when sown in the same area. Numbers indicated that either hairy vetch or sunflower can be seeded previously, but not in the same cover crop mixture. Cover crops terminated through roller crimping favoured wheat (P=0.0012) and canola (P=0.0147) yield more than cover crop incorporation. A cover crop residue mat left from the previous season may have contributed to greater carbon and nitrogen availability and hence allowed these cash crops to get a head start over their counterparts seeded on incorporated plots.

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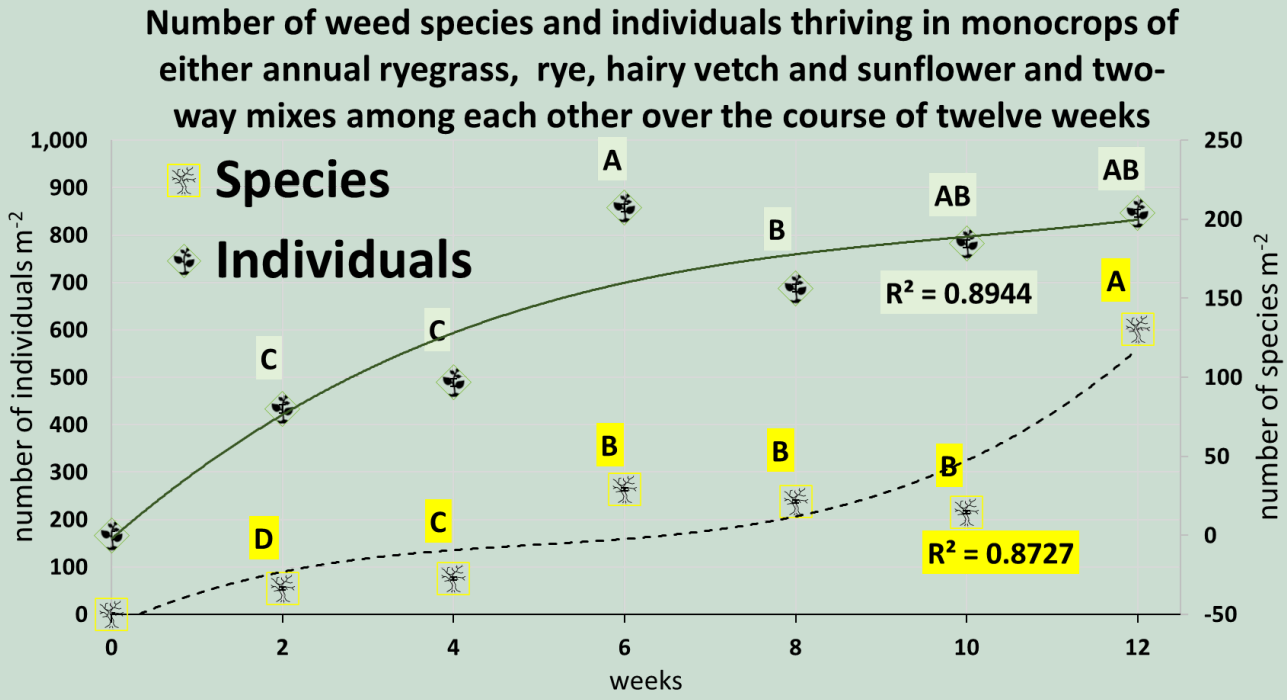
Cover crop seeding, roller crimping and incorporation (First year- 2021 and 2023)



Number of weed species (P=0.3836) and number of individuals (P=0.5312) is statistically the same in either cover crop treatment or mixes of these cover crop species. The only factor influencing number of weed species and number of individuals was time. In other words, two weeks after planting and every two weeks after that, weeds were counted at each plot and these numbers differed at each plot every time they were counted. Number of individuals (P<0.0001) was found to increase as time passed, with a maximum number at six weeks. Number of species (P<0.0001) seemed to increase slowly, stay the same from six to ten weeks and increase again at the end of three months. Both curves for number of weed species and number of individuals show strong correlations. This means that the number of species and individuals changing over time can be modeled to create polynomial equations. These equations could either be used to determine (a) how many weed species, or how many weed individuals can there be at a certain time after cover crop planting, or (b) when would it be expected to reach ten or more weed species, or (c) when would it be expected to reach 300 individuals in total.

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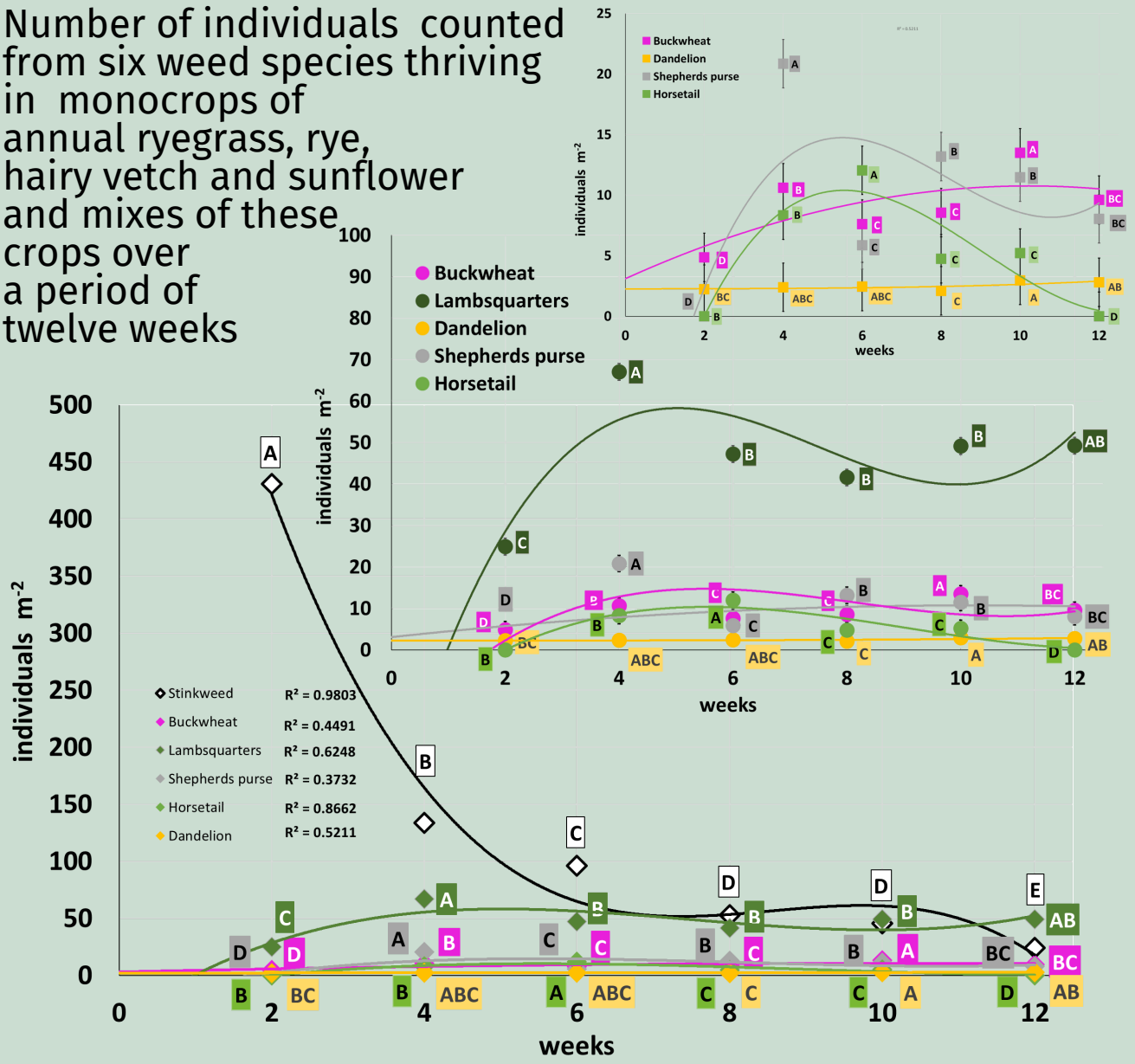
Number of individuals counted from six weed species thriving in monocrops of annual ryegrass, rye, hairy vetch and sunflower and mixes of these crops over a period of twelve weeks



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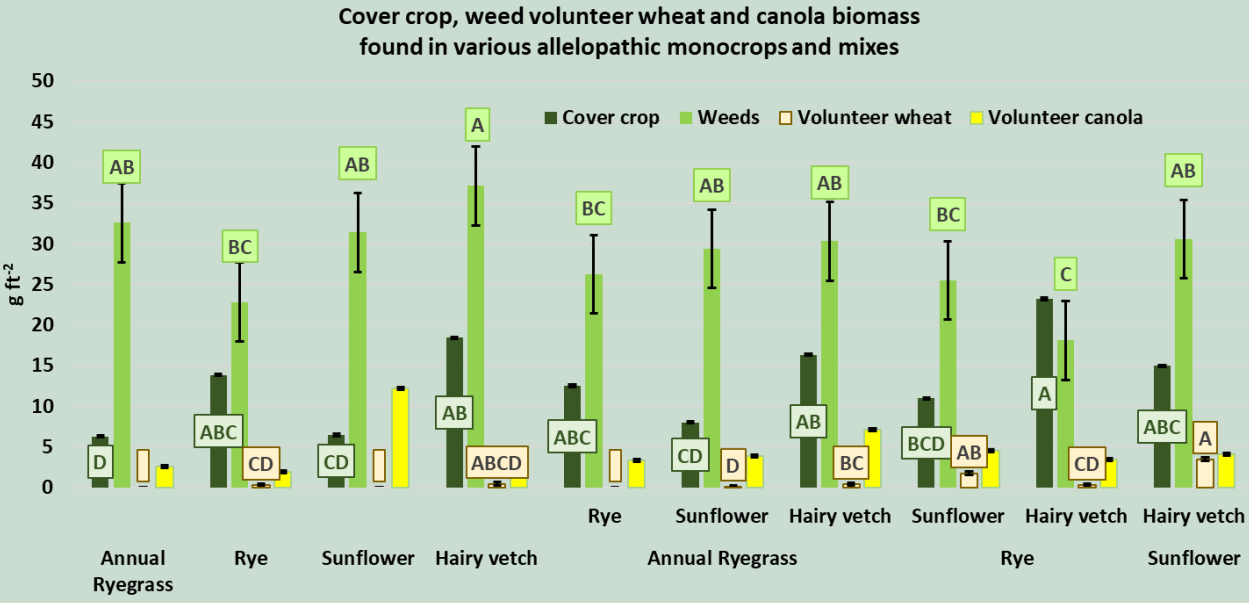
The most common weed species found were wild buckwheat, stinkweed, lambsquarters, dandelion, shepherd's purse, horsetail, clover, sowthistle (annual and perennial) and Canada thistle. Buckwheat ($P<0.0001$), stinkweed ($P<0.0001$), lambsquarters (<0.0001), shepherds' purse ($P<0.0001$), horsetail ($P<0.0001$) and dandelion ($P=0.0145$) number of individuals changed over time. Stinkweed numbers had a decreasing trend. As such, number of mature individuals twelve weeks after cover crop planting were only 5% of the total number of individuals of the same species found at the cotyledon stage ten weeks prior. Buckwheat stands seem to increase four and ten weeks after cover crop planting, but significantly decrease by the end of the season. Lambsquarters and Shepherd' purse individuals had a maximum number at four weeks after cover crop planting. From six to twelve weeks lambsquarters numbers were the same, almost double than the initial value found two weeks after cover crop planting. Shepherd' purse individuals on the other hand decreased after six weeks after cover crop planting and seemed to plateau at the end of the growing season. Number of individuals for the rest of the weed species were not as ubiquitous which makes statistical analysis more difficult to conduct.

Biomass obtained from cover crops, cover crop mixes, weeds, volunteer wheat and volunteer canola were measured in 2023. Biomass produced from cover crops was different ($P=0.0022$), as such, greatest biomass producers in monocrops were hairy vetch and rye compared to annual ryegrass and sunflower. Thus, the cover crop mix with heavier biomass was hairy vetch plus rye, compared to sunflower mixed with either annual ryegrass or rye.



Given that cash crops were sown in 2022, volunteer wheat and canola were found in plots in 2023. Volunteer canola biomass was the same across treatments ($P=0.1401$), but volunteer wheat biomass was greater in plots sown to sunflower + hairy vetch compared to plots sown to annual ryegrass + sunflower ($P=0.0450$). There were no wheat volunteers found in monocrops of annual ryegrass, sunflower or annual ryegrass + rye. Thus, a two-fold possibility could be that (a) annual ryegrass and sunflower reduce wheat volunteers and (b) sunflower allelopathic properties are hindered by hairy vetch, causing volunteer wheat stands to proliferate.

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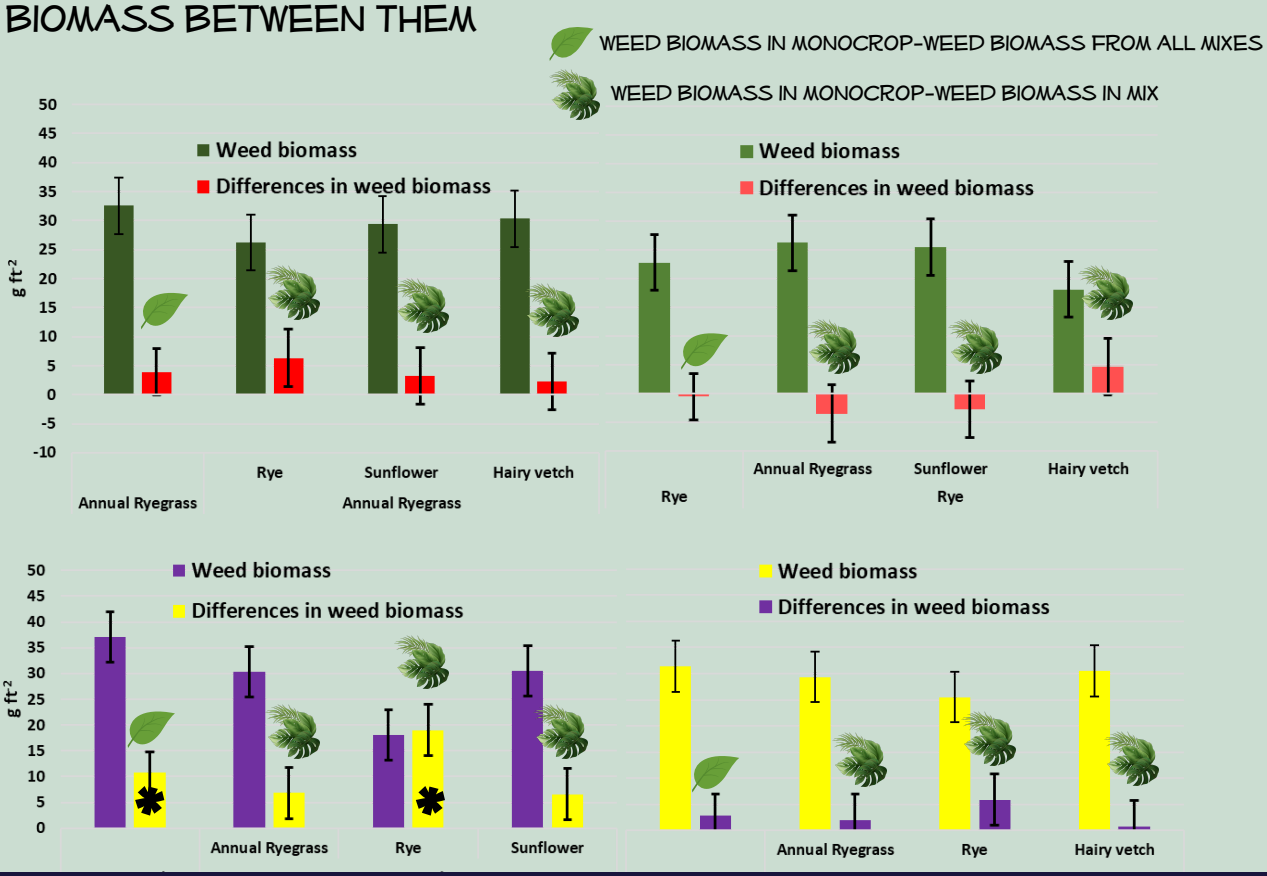
Given that cash crops were sown in 2022, volunteer wheat and canola were found in plots in 2023. Although biomass for volunteer canola was the same across treatments (P=0.1401), volunteer wheat was greater in plots sown to sunflower and hairy vetch compared to plots sown to annual ryegrass and sunflower (P=0.0450). There were no volunteers found in monocrops of annual ryegrass, sunflower or in mixes of annual ryegrass with rye, it can be argued that these crops successfully reduce the emergence of wheat stands the following season. Thus, a two-fold possibility could be that (a) annual ryegrass and sunflower reduce the presence of wheat volunteers the following season and (b) sunflower allelopathic properties are hindered by hairy vetch, causing volunteer wheat stands to proliferate.

WEED BIOMASS COLLECTED IN PLOTS SOWN TO ALLELOPATHIC COVER CROP MONOCROPS AND MIXES AND DIFFERENCES IN WEED BIOMASS BETWEEN THEM



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Basically, allelopathic cover crops that are poor and great weed managers can be divided in two groups. Poor managers were annual ryegrass and sunflower as monocrops, mixes of annual ryegrass with either sunflower of hairy vetch and sunflower and hairy vetch mixes. Great weed managers in contrast were found to be rye, as a monocrop, and rye mixes with the other cover crop tested in this study. To be blunt, weed biomass tells us that greater cover crop biomass does not always guarantee better weed management. Weeds were better managed in mixes of hairy vetch and rye and poor dominion of them was found to be in plots where hairy vetch was sown as a monocrop ($P=0.0203$). This is very interesting because it possible that hairy vetch is acting as a weed smotherer whereas rye is using a greater allelopathic deterrent against weeds. Now one might wonder how different the management of weeds is either as a single allelopathic monocrop or as a mix with another allelopathic cover crop? Differences were calculated as follows: (a) weed biomass found in the allelopathic cover crop monocrop minus composite biomass found in all mixes related to that allelopathic cover crop and (b) weed biomass of allelopathic cover crop minus weed biomass of each of the mixes related to that allelopathic cover crop. Notice that hairy vetch has two stars, one over the difference between weed biomass in hairy vetch minus composite of all hairy vetch mixes and in the difference in weed biomass found between hairy vetch monocrops versus weed biomass found in mixes of hairy vetch and rye. These stars mean that the values are statistically different, meaning weed biomass in hairy vetch monocrops was much greater than weed biomass found in hairy vetch mixes combined. Moreover, plots seeded to hairy vetch and rye had less weed biomass than plots seeded to monocrops of hairy vetch.

Overall, no cover crop species or cover crop mixes influenced weed species and number of weeds, however, both species and stand number do tend to decrease over time, but this is likely due to interspecific competition, not only with cover crop species but also with other weeds species. However, weed biomass provides a different story. It shows that rye has great allelopathic properties and mixes with other cover crops, especially hairy vetch might can be effective to reduce presence of weeds.

KEY POINTS:

- **There is no effect of cover crop species or cover crop mixes on weed species or number of weed individuals**
- **The top ten most common weed species were wild buckwheat, stinkweed, lambsquarters, dandelion, shepherd's purse, horsetail, clover, sowthistle (annual and perennial) and Canada thistle**
- **Weed biomass in hairy vetch monocrops was much greater than weed biomass found in hairy vetch mixes. Moreover, plots seeded to hairy vetch and rye had less weed biomass than plots seeded to monocrops of hairy vetch**