environment, the plants were smaller and could not produce the same resources for seed set. These factors likely are responsible for the yield losses with delayed seeding.

Table 2. Average flea beetle damage score (scale of 1 to 9 with 9 being no damage), seed yield (lb. per acre), and oil content (%) of five canola, rapeseed, and mustard cultivars with three seeding dates when grown near Moscow, Idaho in 2018, 2019 and 2020.

Seeding Dates	Flea Beetle Damage (1-9 score, higher is better)	Seed Yield (lb./acre)	Oil Content (percent)
Early	7.2 [b]	2,470 [a]	42.9 [a]
Intermediate	7.0 [a]	1,964 [b]	42.2 [a]
Late	7.5 [c]	1,086 [c]	39.7 [b]
LSD (p=0.05)	0.2	186	1.0

Means within columns with different superscript letters are significantly different ($P<0.05$).

This study showed that delaying planting until late May resulted in a slight decrease in flea beetle damage, perhaps due to a cessation of feeding as the adult flea beetles completed their life cycle and died, but any positive effect was far outweighed by yield losses associated with delayed planting. The study also showed that even with relatively low flea beetle pressure, a foliar application of insecticide can be justified and will increase seed yields of spring canola. At a canola price of 20 cents per pound, the average seed yield increase of 212 lb. per acre observed in the trial has a value of $42 per acre, which should cover the cost of insecticide and application. With higher flea beetle pressure and the current higher prices, the economic return of an insecticide application would be greater.

Table 3. Average flower date, days from seeding to 50% flowering, and plant canopy height of five canola, rapeseed, and mustard cultivars with three seeding dates when grown near Moscow, Idaho in 2018, 2019, and 2020.

Seeding Dates	50% Flower Date	Days to 50% Flower	Plant Height (inches)
Early	June 17 [a]	51 [a]	44 [a]
Intermediate	June 27 [b]	45 [b]	42 [b]
Late	July 8 [c]	43 [c]	39 [c]
LSD (p=0.05)	0.3	0.3	1.8

Means within columns with different superscript letters are significantly different ($P<0.05$).

Use of Agronomic Approaches to Improve Stand Establishment in Winter Canola

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Expanding oilseed cultivation in the Pacific Northwest (PNW) is important not only for the edible oil production for human consumption but also as a rotation crop with winter wheat. Both winter and spring canola are being grown in the PNW, but winter canola has more yield potential compared to spring canola in this region. Winter survival of canola depends on many factors including the planting date, seeding depth, seeding rate, plant stature, and cultivar genetics. Our lab is using a combination of molecular and agronomic approaches to study and improve the winter survivability of winter canola in the inland PNW.

Improved stand establishment via early planting results in an increase in plant size. This increase in plant size, however, can favor winter kill. We are using the plant growth inhibitor paclobutrazol to manipulate plant growth of early planted winter canola. We have carried out experiment to determine the optimum concentration of paclobutrazol for reducing plant height in early seeded canola. Due to the unavailability of commercial paclobutrazol for canola, we chose to make our own product in-lab to determine the working solution for controlling plant height at seedling stages. Paclobutrazol powder from PhytoTechnology Laboratories was used to make spray solutions. The following rates were used to determine the optimum dose and study its effect on canola seedling growth: 150mg/200ml, 300 mg/200ml, and 400 mg/200ml. A series of greenhouse experiment showed that the 150mg/200ml rate effectively reduced seedling growth (Fig 1).

Figure 1. Control (left) vs. Paclobutrazol (right) (150mg/200ml) in greenhouse trials.

Based on our greenhouse trials, a rate of 150mg/200ml was also used in field experiments at the Washington State University Grass Breeding and Ecology Farm in Pullman, WA. Paclobutrazol was applied early in the day to avoid transpiration of the chemical solution and to enable the maximum absorption of solution in plant leaves. Plants treated with chemicals showed reduced height with leaves appearing to spread around the crown and no upward growth for the first two weeks (Fig. 2). Spreading of leaves around the crown may provide protection against frost and low winter temperatures. The same experiment will be repeated this year on early planted canola to study the winter survival of treated and untreated plots.

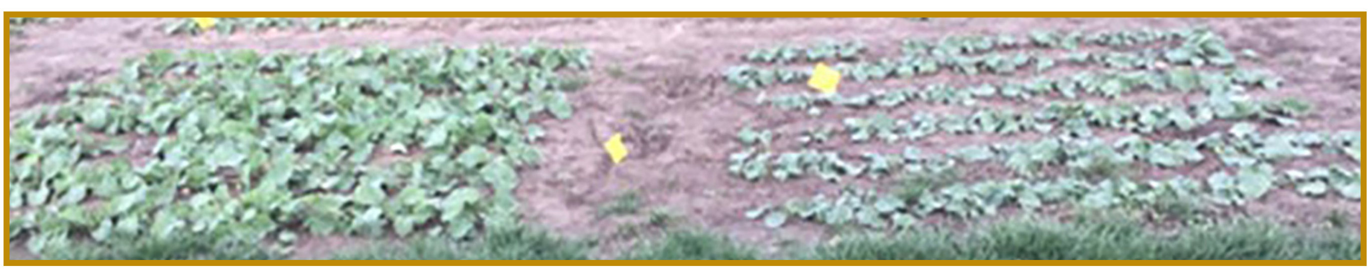

Figure 2. Control (left) vs. Paclobutrazol (right) (150mg/200ml) in field trials.

Our lab is also carrying out a winter tolerance screen on a collection of *Brassica napus* germplasm grown in the inland PNW region. A collection of 144 winter *Brassica napus* accessions is being screened at the Washington State University Grass Breeding and Ecology Farm in Pullman, WA for yield and winter survivability (Fig 3). A multi-year trial of this experiment is being conducted to understand the genetics of winter tolerance, as well as identify lines with better winter survival and yield to incorporate in future winter canola breeding programs at Washington State University.

Together, these agronomic approaches should help us develope new agronomic practices and germplasm with better stand establishment and winter-kill tolerance. As a result, these studies may help farmers in the inland PNW plant more acres of winter canola.

Figure 3. Screening of Brassica napus accession in the field for yield and winter tolerance.

Plant Density and Pod Count Variation Within Large-Scale Variety Trials

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In addition to yield data, large-scale variety trials can be utilized to improve out understanding on a variety of other yield related variables. During the summers of 2019 or 2020 plant counts were collected at all the large-scale variety trial locations for a total of five site years. Additionally, pod counts were collected at two locations in 2019 and two locations in 2020 for a total of four site years of data. The importance of stand and pod count have been discussed previously and various research has sought to form connections between stand count and yield as well as the pod count and yield. In five site years stand count data was not correlated with yield at the field scale (figure 1). The average stand count within each strip ranged from 1-7 plants ft^{-2}. These results indicate that spring canola yield is stable over a wide range of stand densities. The branching architecture of canola allows it to develop a full canopy when plant density is low. A clear example of this is in the Cloverland 2020 data. Over the five stie years Cloverland was among the lowest plant densities and had the highest yield. Untimely frost, inappropriate nitrogen applications, low moisture, and insect pressure may all result in poor stands. However, no clear guidance for replant decisions can be found in the regional literature. Our future research will focus on developing decision support for replant. In light of the weak correlation between stand count and yield, some have hypothesized a correlation between pod count and yield. However, in our research no inter year correlations between pod count and yield have been achieved. Future research will focus on a more robust spatial analysis of plant density and pod count.

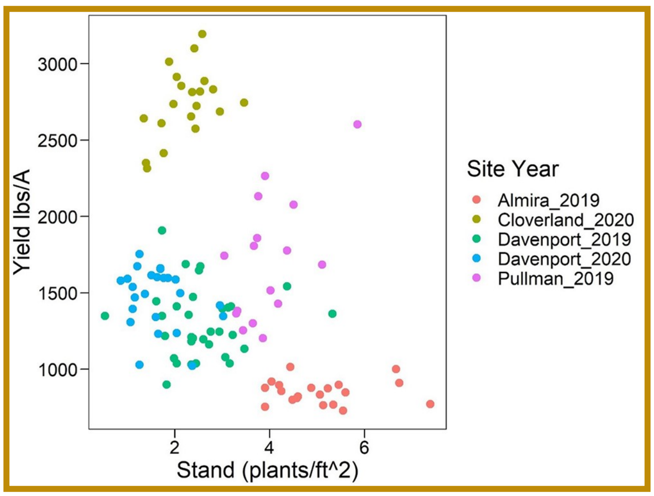

Figure 1. Stand count and yield from five site years of spring canola data. It appears that no relationship between stand count and yield exists even at low stand densities < 2 plants ft^{-2} high yields can be achieved as is seen in Cloverland 2020.