Fairbanks Cover Crop Variety Trial Final Report

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Fairbanks Soil and Water Conservation District

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Introduction

Cover crops are critical for maintaining soil health and have been widely adopted into conventional agricultural practices. They reduce soil erosion, supply nutrients and increase availability, support a diverse soil microbiome, provide forage, suppress weeds, and create further economic opportunities (Reicosky and Forcella 1998, SAN 2007, Blanco-Canqui et al. 2015). While cover crops have become an important part of agriculture, they have not been routinely applied in Alaska due to lack of knowledge about their suitability, the short-growing season which does not allow off-season or staggered multi-year planting, and the increased costs of a secondary crop (Carr 2021).

Alaska is a unique agricultural system with many challenges that increase risk such as cold soil temperatures, late last frost-free date, unpredictable late summer frosts, and long sunlit days resulting in a short, intense growing season. In addition to climate restrictions, there are socioeconomic and cultural challenges such as lack of farming infrastructure, long-term place-based farmer knowledge, access to farm land, and the high cost of shipping supplies that can make farming more difficult in the subarctic climate (Stevenson et al. 2014). While advancements in soil health understanding such as the use of cover crops have made it to farms in Alaska, the perception may still remain that overcoming these challenges to plant a secondary crop may not be worth the soil health benefits (Clay et al. 2020).

Despite challenging environmental conditions, Alaska has a long farming history due to its remoteness, food insecurity, growing population, and industrious inhabitants (Thomas and Lewis 1981, Papp and Phillips 2007). Today, conventional farming, market gardening, and subsistence agriculture are growing in Alaska. According to the 2022 State Agricultural Overview, there were 1000 farm operations in Alaska and this number has increased from 574 farms in 1987 to 990 farms in 2017. This trend is reflected in interior Alaska where, in 2017, there were 274 farms in the Fairbanks North Star Borough up from 217 farms in 2012. For Alaska, a growing number of farms typically means the conversion of raw land to agricultural land highlighting the need for restorative soil health practices such as cover cropping.

Together, with the Natural Resources Conservation Service Alaska (NRCS) and Alaska Association of Conservation Districts (AACD), we embarked on a two-year partnership to study over twenty varieties of cover crops and how they perform across Alaska. Seven sites were selected and at each site a Soil and Water Conservation District implemented the variety trial. The seven sites selected were Homer, Kenai, Palmer, Wasilla, Copper Valley, Salcha Delta, and Fairbanks. In this paper, we discuss the variety trials located in Fairbanks, Alaska (Figure 1). Ultimately, we seek to encourage farmers to plant cover crops to nurture their soil health by supplying them with the needed knowledge of cover crop suitability for interior Alaska.

Study Site

Interior Alaska varies substantially from other agricultural sites in Alaska by both climate and topography. The landscape of the Tanana River Valley is an alluvial terrace fan radiating northward from Alaska Range. The Yukon Tanana Uplands flank these lowlands and rise to 3000 feet above the valley floor. The most common soil type is the Tanana soil series, which is poorly drained and permafrost limited. Above the permafrost are black spruce forests and numerous wetlands. Where permafrost has thawed white spruce and birch forests are common. The climate is typically long, dark, and cold winters followed by short, sunlit, and warm summers. Fairbanks precipitation ranges from 10-14 inches in the summer. The average summer time temperatures are as follows (low-high): April 21°F – 44°F; May 38°F – 61°F; June 49°F – 72°F; July 52°F-73°F; August 46°F – 66°F; and September 35°F – 55°F. The average last frost-free day is June 1 and first frosts start around September 1, earlier in the lowlands and valleys. The USDA Plant Hardiness zones for interior Alaska are 1b, 2a, 2b, 3a, and 3b depending upon elevation and aspect.

We selected the University of Alaska Fairbanks (UAF) Fairbanks Experiment Farm (FEF) as our trial location. In conjunction with the Matanuska Experiment Farm and Extension Center, this agricultural experiment station has over a 100-year-old tradition of agricultural research, growing crops, animal husbandry, and variety development. It is noted for developing varieties particularly suited to interior Alaska growing conditions such as Sunshine Hulless Barley, Barley Otal, Deltana Polish Canola, and Midnight Sun-flower (Van Veldhuizen et al. 2014). Today, the primary purpose of the FEF is to conduct modern vegetable and grain variety trials, maintain soil health, and respond to contemporary agricultural needs within the community.

The plant hardiness zone for the FEF is 2b (-45°F to -40°F/-42.8°C to -40°C). The soil type is Tanana Mucky Silt Loam with a high run-off potential and short distance to water table; however, farming successively in this location has fundamentally changed the soil type over the years. For our trial location on the FEF, the soil pH is 6.8 and level of organic matter is 4% (Appendix B).

Methods

In May 2021, we set up an approximately half acre site with four replicates, each 25' wide by 240' long. Within the replicate, there were 24 plots with single plot dimensions of 10'L x 25' W. We collected a composite soil sample from the site for nutrient analysis and guiding fertilizer recommendations. We fertilized according to the soil test report and the Alaska Agronomy Technical Note 16, which was the maintenance rate for cereal crops and forage grasses in interior Alaska. We applied N-P-K-S (12.4 – 2.75 – 2.75 – 1.377 per 6,000 ft^2). This worked out to be 105 pounds of urea, 24 pounds of triple super phosphate, and 22 pounds of potassium sulfate which also supplied sulphur.

Prior to planting, farm staff at the FEF prepared the field by standard and rotura discing. We planted the fields June 14-16, 2021 and June 14-16, 2022 with completion of planting on June 16 in each year. To plant we divided seed evenly into four parts followed by 4 quadrants (resulting in 1/16th). To ensure consistent coverage in broadcasting, we set up string line quadrants and marked all outlines. We hand broadcasted the seed and raked in larger seed to two inches while smaller seed was dragged to ¼ inch. We did not supply the crops with irrigation or early season weeding to get established nor throughout the season.

We planted 23 varieties in 6 different families and 12 functional groups: barley, oats, clover, radish, turnip, field peas, mustard, sunflower, buckwheat, flax, rye, and triticale. (For the full list of varieties see Appendix A). We took measurements at either one week or two week intervals: emergence, plant height, canopy cover, antithesis, and biomass.

Emergence: We began monitoring emergence every week starting seven days after planting until fifty-six days after planting. We categorized emergence by the following criteria – 1: 0-25%; 2: 25-65%; 3: 60-85%; and 4: 85-100%. For the data analysis we combined emergence levels across the four plots annually to represent variety emergence. We then analyzed the time to full emergence (85-100%) by calculating and ordered this by variety for each year. We considered the varieties with the best emergence to be those that reached full emergence in the shortest amount of time.

Plant Height - We monitored plant height every two weeks starting fourteen days after planting until termination. We took three plant height measurements in each plot for a total of 12 measurements per variety per sampling occasion. We repeated these measurements in two-week intervals starting at 14

DAP until termination at 63 DAP. For the data analysis, we averaged the 12 measurements and used the maximum plant height then ordered this by variety.

Canopy Cover - We monitored canopy cover starting fourteen days after planting until termination. We defined canopy cover as the percentage of the soil surface covered by plant foliage. This included plant stems but was primarily made up of leaves and the tops or crowns of the plants as viewed from above the vegetation. To evaluate canopy cover, we used the following rating scale: 1=1%-20%; 2=21%-40%; 3=41%-60%; 4=61%-80%; and 5=81%-100%. This represented the cover of the bare soil by the plant.

Antithesis - We monitored bloom status twenty-eight days after planting until termination. We defined antithesis as the physiological growth stage where the plants were in 50% bloom, or about halfway between the start of bloom and peak bloom. Antithesis is a good indicator of pollinator habitat and optimum nitrogen content. Not all the species bloomed, depending upon their species and variety. We assessed bloom every week after initial bloom. We collected information on bloom status once plants began to bloom. We classified bloom of grasses if the inflorescence was showing but the reproductive parts were still inside the flower.

Biomass - We took biomass measurements from August 8-10, 2021, which was fifty-four to fifty-six days after planting and from August 15-16, 2022. We measured crop height first and then used a 0.5 meter three-sided quadrant made of PVC pipe to clip a representative sample of the plot. We made sure that all four plots of the same variety were collected on the same day before placing the sample in a drying oven. We collected above-ground biomass for every plot in a 0.5 M2 quadrat. We selected an area that was representative of the density of the greater plot and trimmed all above ground vegetation to ¼ inch stubble height. We weighed the wet sample and then took a smaller sample 200-300 grams, which we dried using a drying oven. We dried the samples for 2-4 days until the final dry weight was stable. This sample dry weight was then extrapolated back to the 0.5 M2 square. We plotted the quadrat dry weight and ordered the weights by variety.

In addition to these weekly measurements, we also described relative weed suppression by the variety as well as animal activity such as sandhill cranes or Canada geese and collected soil moisture readings. We continued crop measurements past biomass sampling until sixty-three days after planting. Termination was initiated in accordance with farm schedules, weather, and personnel availability. The variety trials were officially terminated on August 30, 2021, which was seventy-five days after planting. In 2022, the variety trials were officially terminated on August 29. Each year, the crop was terminated through conventional tillage and was treated twice. There were no surviving plants after termination.

Results

Emergence – Emergence of varieties was different from year 1 to year 2 of the trial, following rainfall differences (Figures 2-5). Rapid emergence following early season precipitation occurred in year 1 with the first varieties reaching full emergence (85-100%) by 7 DAP (Figure 6). However, a month-long drought after planting in year 2 (Figure 3, Figure 5) delayed emergence of all varieties and it was 21 DAP before the first variety reached full emergence (Figure 7). After accounting for annual differences, Turnip Turbo, Barley Sunshine, and Barley Otal were in the top 5 fastest varieties to reach full emergence for both years. In 2021, all varieties reached full emergence but in 2022 there were 5 varieties that did not reach full emergence by 56 DAP (Figure 7).

Plant Height – Mancan Buckwheat and both Radish varieties were the top three tallest plants in both 2021 and 2022 (Figure 8, 9). Also growing consistently by year, Wyoming Winter Peas were part of the top five tallest varieties and Black Oil Sunflower was the 6th and 7th tallest plant in 2021 and 2022. All varieties of Red Clover were among the shortest plants in the trial but performed better in 2021. Collards and turnips were short in 2021 but grew higher in 2022. After accounting for the tallest and shortest plants, there was a greater level of annual variability in the middle height varieties.

Canopy Cover – Mustard White Gold was the fastest to reach full canopy cover in 2021 (Figure 10) and among the fastest in 2022 (Figure 11). Other rapid varieties were Barley Sunshine, Radish Nitro, Radish Nematode Control, Turnip Purple Top, Turnip Turbo, Collards, Rye Berberal, Triticale 813 Winter, and Triticale FX Winter. In 2022, it took longer for varieties to reach full canopy cover. For example, 83.3% of varieties in 2021 were at full canopy cover by 42 DAP compared to 45.8% of varieties in 2022. In 2021, all varieties reached full canopy cover but in 2022 there were seven varieties that did not reach full canopy cover (Figure 11).

Antithesis – Mustard White Gold had the earliest initial bloom, 50% bloom, and 100% bloom in both 2021 and 2022 (Figure 12,13), completing its bloom cycle in 4 and 5 weeks respectively. Barley Otal, Buckwheat Mancan, and Barley Sunshine were in the top seven earliest bloomers in both years. Red Clover Mammoth, Turnip Purple Top, Turnip Turbo, Collards, Rye Berberal, Triticale FX Winter, and Sunflower Black Oil did not bloom in either year in our monitoring window though Sunflower Black Oil was on the cusp of blooming. In 2021, most varieties were quicker to reach 100% bloom with a shorter time between 50% anthesis and 100% anthesis while in 2022, varieties had increased time to 50% anthesis, increased time in 50% anthesis, and delayed 100% anthesis.

Biomass – There was greater variability in biomass weights for cover crop varieties in 2022 than 2021 (Figure 14). In 2021, Sunshine Barley, Black Oil Sunflower, and Mancan Buckwheat produced the greatest amount of biomass while Purple Top Turnip, Berberal Rye, and FX Winter Triticale were the least producers (Figure 15). In 2022, Black Oil Sunflower produced the greatest biomass followed by Nematode Control Radish and Mancan Buckwheat (Figure 16). The least amount of biomass produced in 2022 was by all three red clover varieties: Mammoth, Medium, and Kenland (Figure 16).

Discussion

Our variety trial provides much needed information on the suitability of single varieties of cover crops for interior Alaska. There were clear stand outs in terms of emergence and biomass such as Barley Sunshine and Buckwheat Mancan. Other varieties were great for pollinators such as Mustard White Gold, Radish Nematode Control, Radish Nitro, and Flax Golden. For canopy cover, the brassicas and grasses were the top performers. Conversely, there were also varieties that could be weed threats if not properly managed. Mustard White Gold was phenomenal for pollinators but completed its life cycle within four weeks in our warm and dry interior Alaska summer increasing the probability of shattering and leaving mature seed to overwinter in the ground. Buckwheat, perennial rye, and clover could be problematic if allowed to establish but establishment of these plants could be a goal of the farmer who may be interested in forage and honey production.

Cover crop selection will include best performers but should also consider multiple scenarios and objectives. Economics and availability of seed including local sources are strong drivers of selection but so is the primary objective of planting the cover crop. The main purpose may be to improve and build soil health; cover fallow fields and prevent erosion; attract pollinators for crop pollination, pest management, and honey crops; plant as conservation cover or perennial forage grass; or suppress weeds. Oftentimes a single variety can serve multiple purposes and a mixture of varieties can be even more functional. For example, the Alaska Plant Materials Center found that Timothy (Phleum pratense), a common hay species, not only provides forage but is also very good at improving soil health (Cole 2018), possibly because Timothy is good at establishing in Alaska's generally acidic soils.

For interior Alaska, we recommend using our trial results to guide future research and development of mixed variety cover crop plantings (mixtures). We tentatively recommend planting Barley Sunshine, Pea Austrian or Wyoming Winter, Radish Nitro, and Red Clover Kenland or Medium as a mixture. Barley would be good for suppressing weeds but still allow enough light for clover to get established and provide structure for peas to grow upward. The radish would help break up soil compaction and attract pollinators and barley and radish would provide significant biomass. An alternative mixture would be buckwheat, sunflower, oats, and field peas.

In addition to testing mixtures, we recommend demonstrations of cover crops on recently cleared farm land that is being brought into new production. With steady increases in the number of farms every decade as well as planned State of Alaska agricultural land disposals such as the Nenana Totchaket Agricultural Project, the conversion of raw land to farm land is the best starting point to begin thinking about soil health.

Another area of research would be testing in season plantings either before or after cash crops or intercropping within cash crops. While these are not traditional cover crop scenarios for Alaskan farmers due to the short growing seasons, our trials indicate there are some varieties that could fill this need. Alaskans have used cover crops on fallow fields, as intercropping between rows of peonies or cut flowers, as nitrogen credits, to increase forage opportunities, and to build organic matter. More research is needed to not only simulate the best rotation scenarios for specific crops but also to demonstrate the diverse ways that this practice can be employed under these current scenarios.

Advances in soil health understanding do apply to Alaska's cold soils and the success of our trials shows that a cover crop practice is feasible as part of an annual crop rotation with the potential for much greater utilization.

Acknowledgements

The University of Alaska Fairbanks Experiment Farm (FEF) was critical to the implementation of our variety trial. FEF Farm Managers Alan Tonne and Kieran Gleason provided location, cultivation and equipment, historical context, laboratory space, termination, and general farming expertise. Hazel Berrios, Limor Dubrovsky, and Emily Hikes were the technicians on this project; involved in planting, weekly monitoring, harvesting, and weeding walkways. Jennifer McBeath and Dennis Fielding performed collateral work on the soil microbiome and insect infestations of our plots.

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Tables and Figures

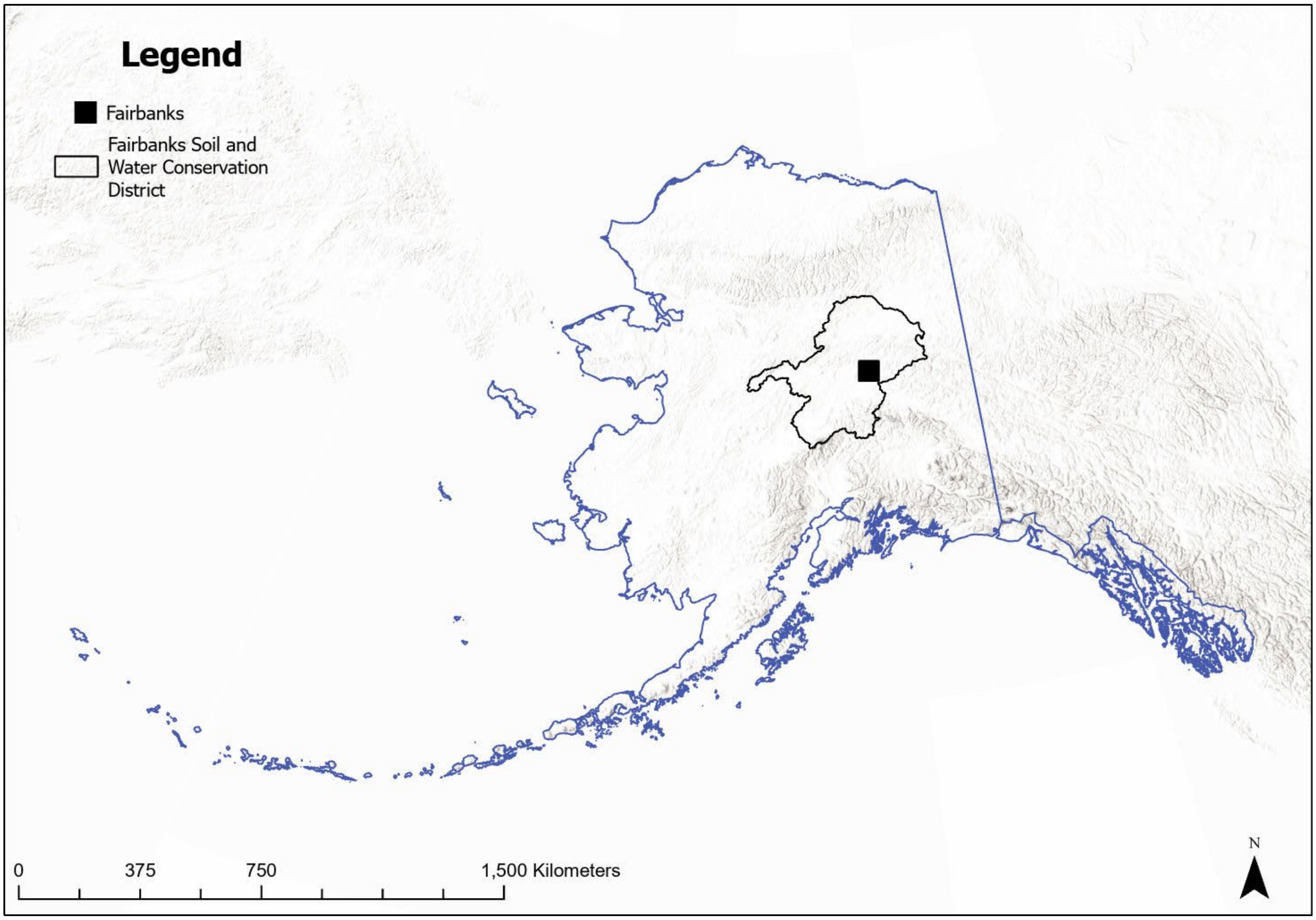

Figure 1. General location of study area for cover crop variety trial in interior Alaska, 2021-2022.

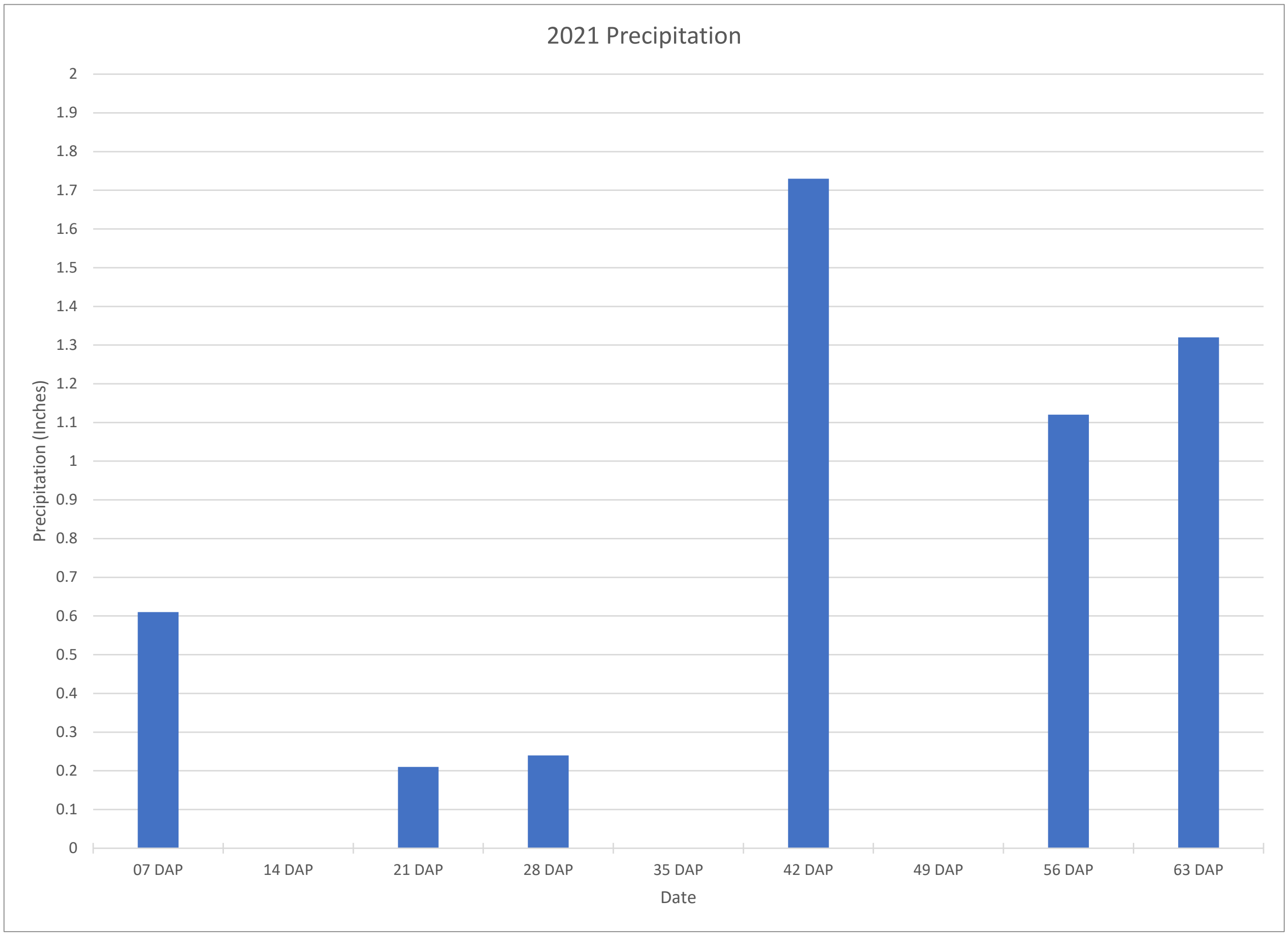

Figure 2. Precipitation (inches) by days after planting for Fairbanks, Alaska, 2021.

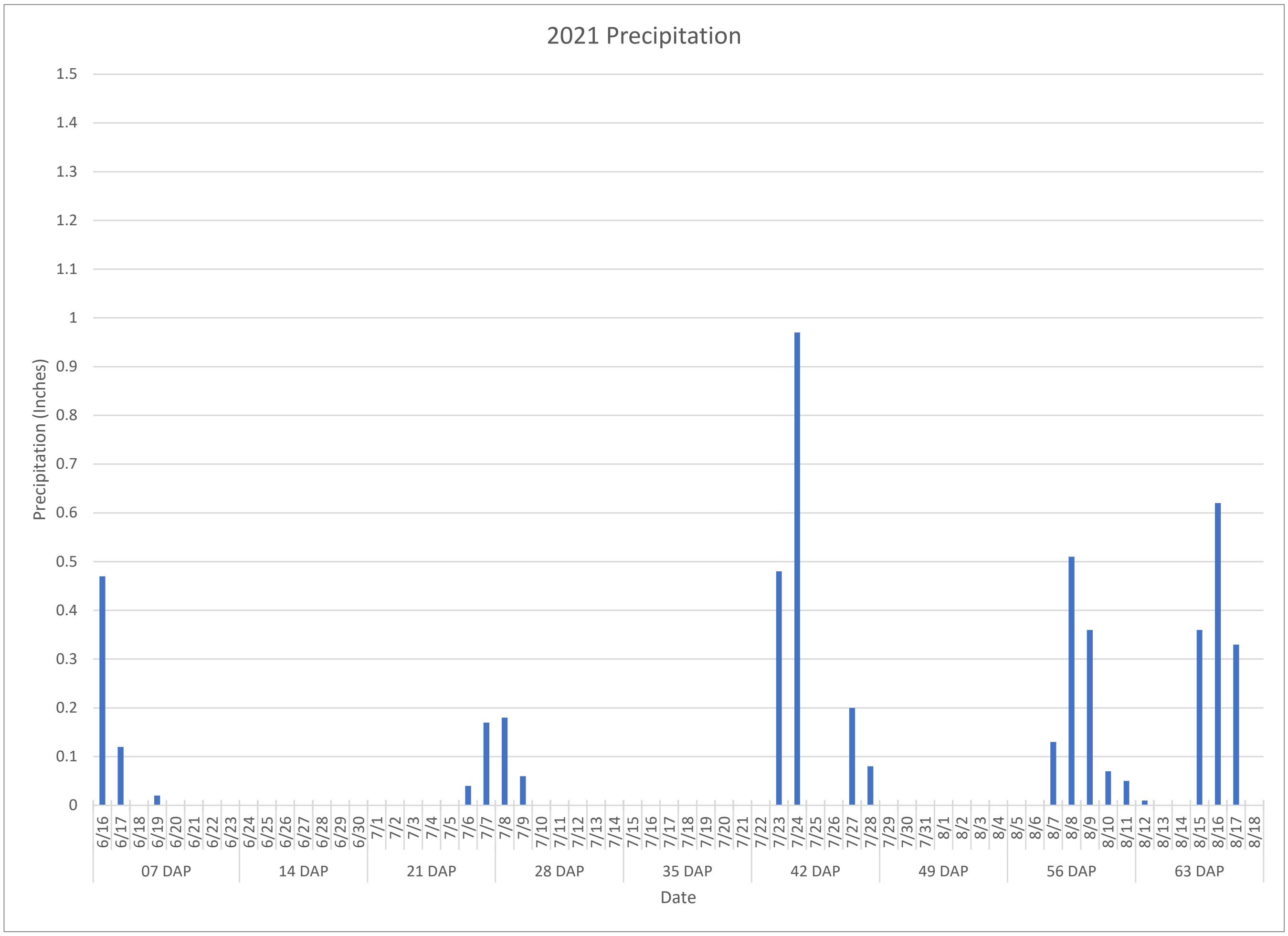

Figure 3. Precipitation (inches) by date for Fairbanks, Alaska, 2021.

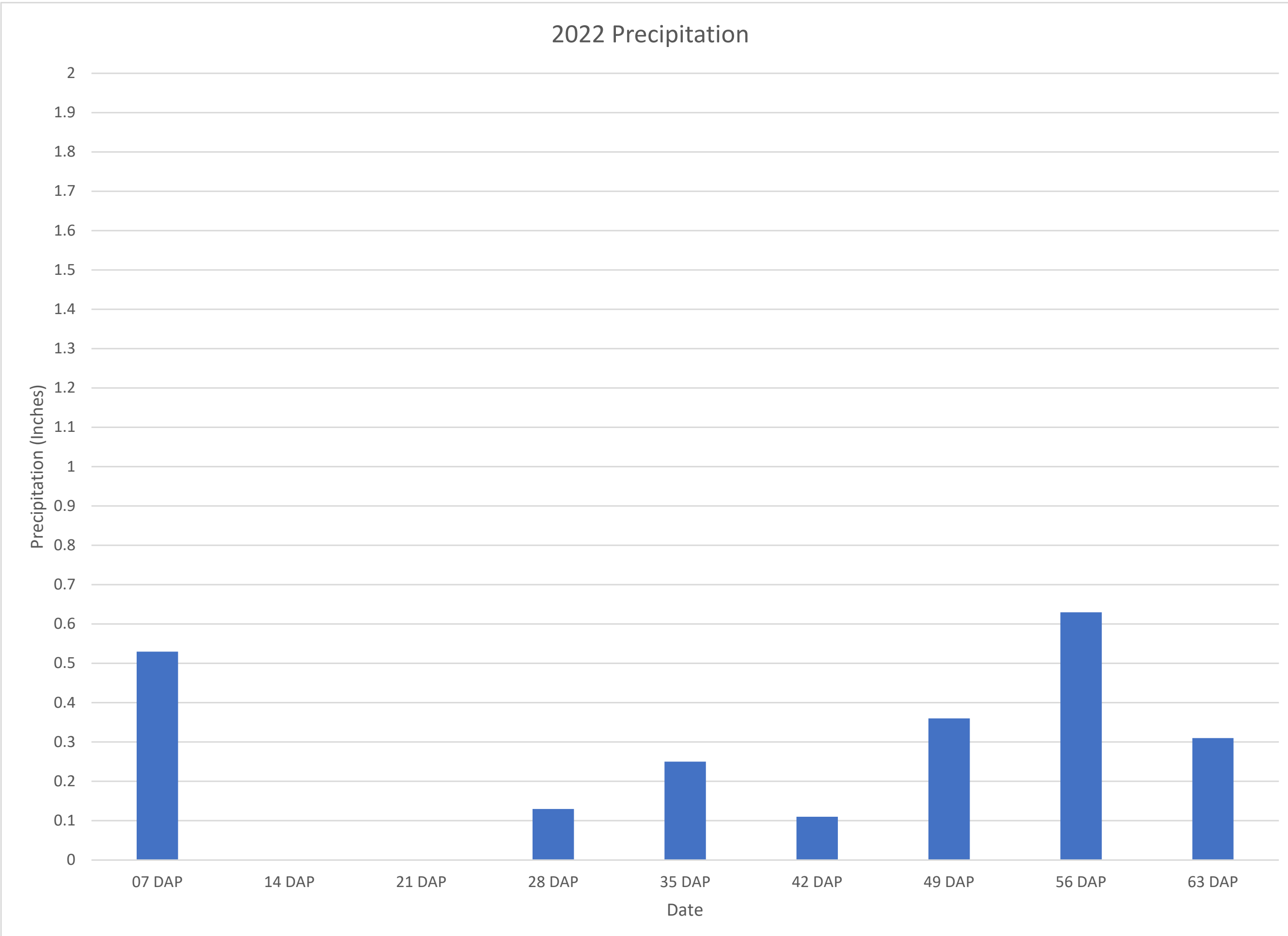

Figure 4. Precipitation (inches) by days after planting for Fairbanks, Alaska, 2022.

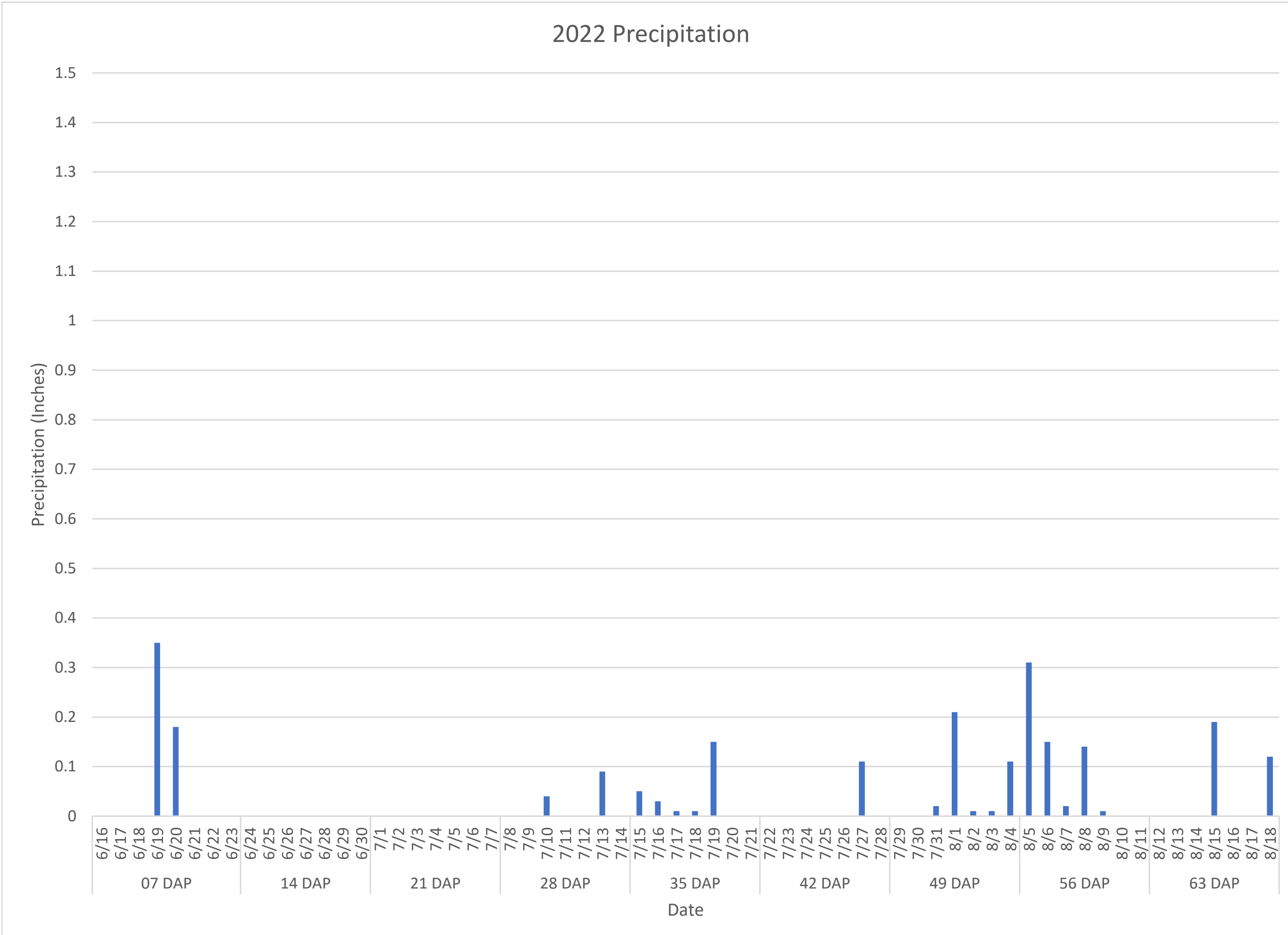

Figure 5. Precipitation (inches) by date for Fairbanks, Alaska, 2022

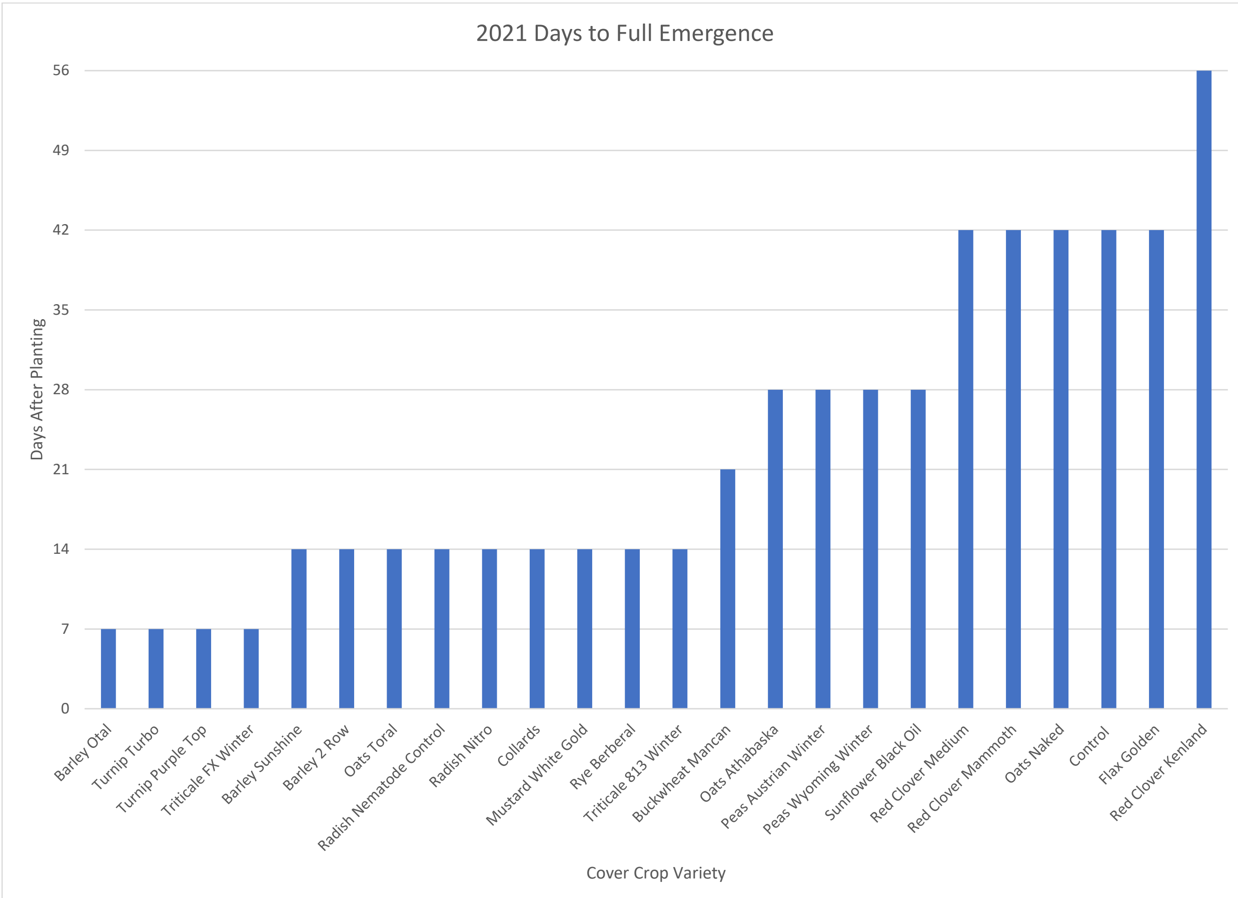

Figure 6. Time (days after planting) to full emergence (85-100%) of cover crop varieties ordered from most rapid (left) to slowest (right) in Fairbanks, Alaska, 2021.

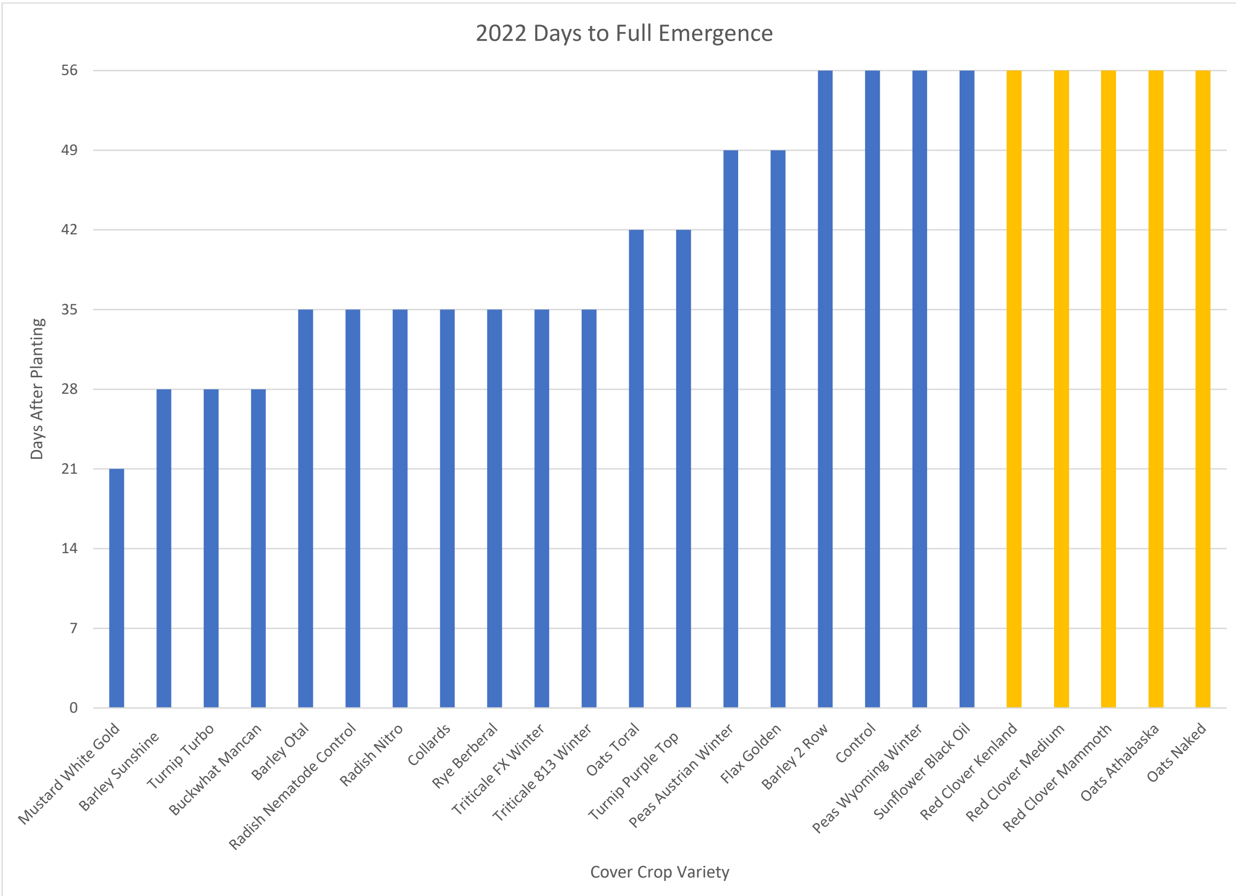

Figure 7. Time (days after planting) to full emergence (85-100%) of cover crop varieties ordered from most rapid (left) to slowest (right) in Fairbanks, Alaska, 2022. The yellow bars indicate varieties that did not fully emerge at 56 days after planting.

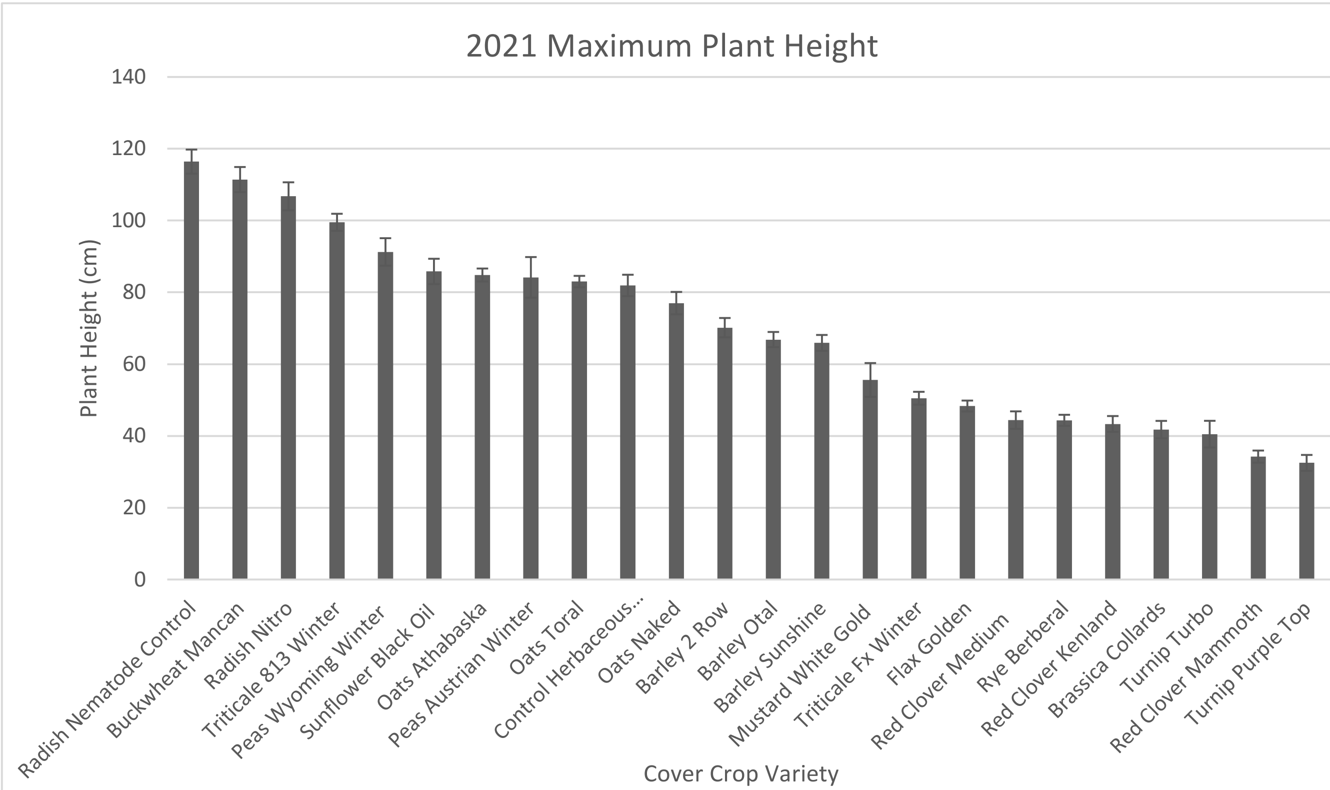

Figure 8. Maximum plant height of cover crop varieties ordered from tallest (left) to shortest (right) in Fairbanks, Alaska, 2021.

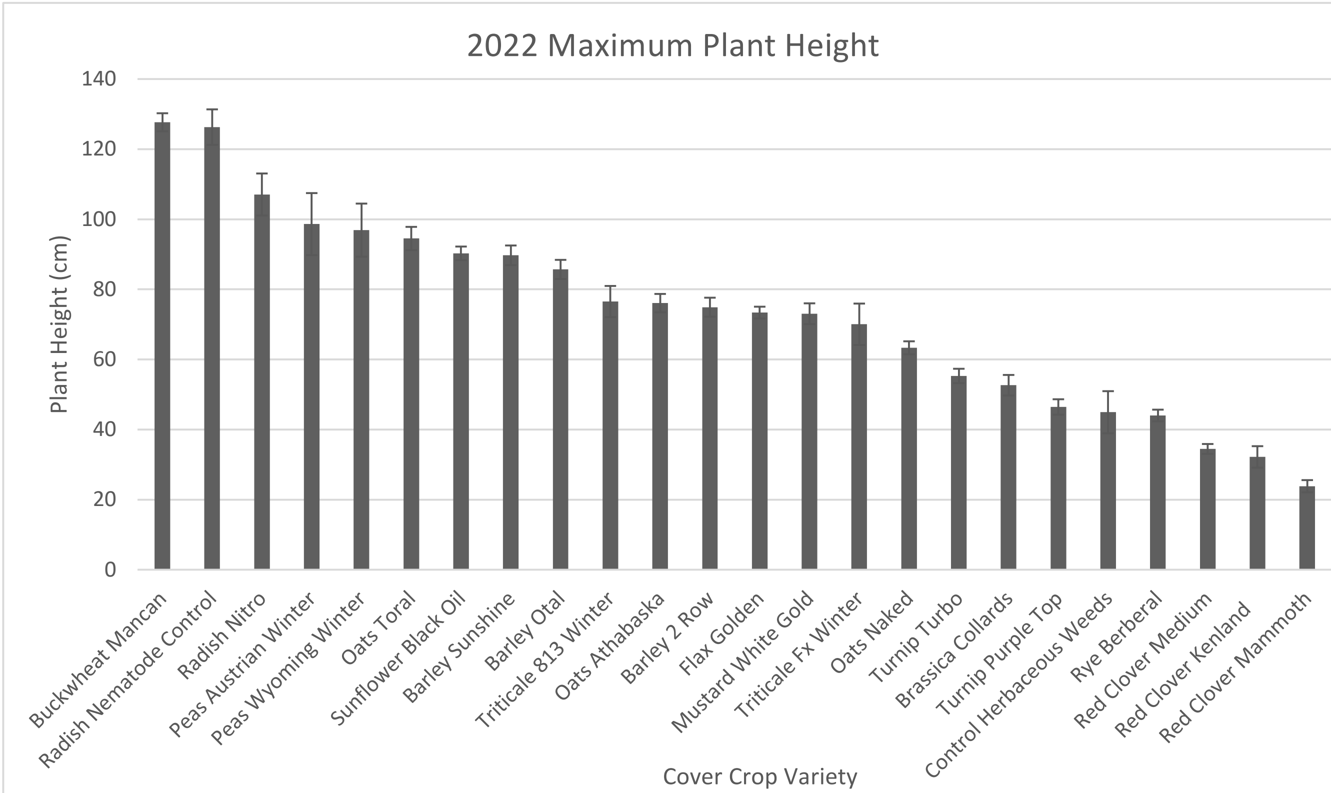

Figure 9. Maximum plant height of cover crop varieties ordered from tallest (left) to shortest (right) in Fairbanks, Alaska, 2022.

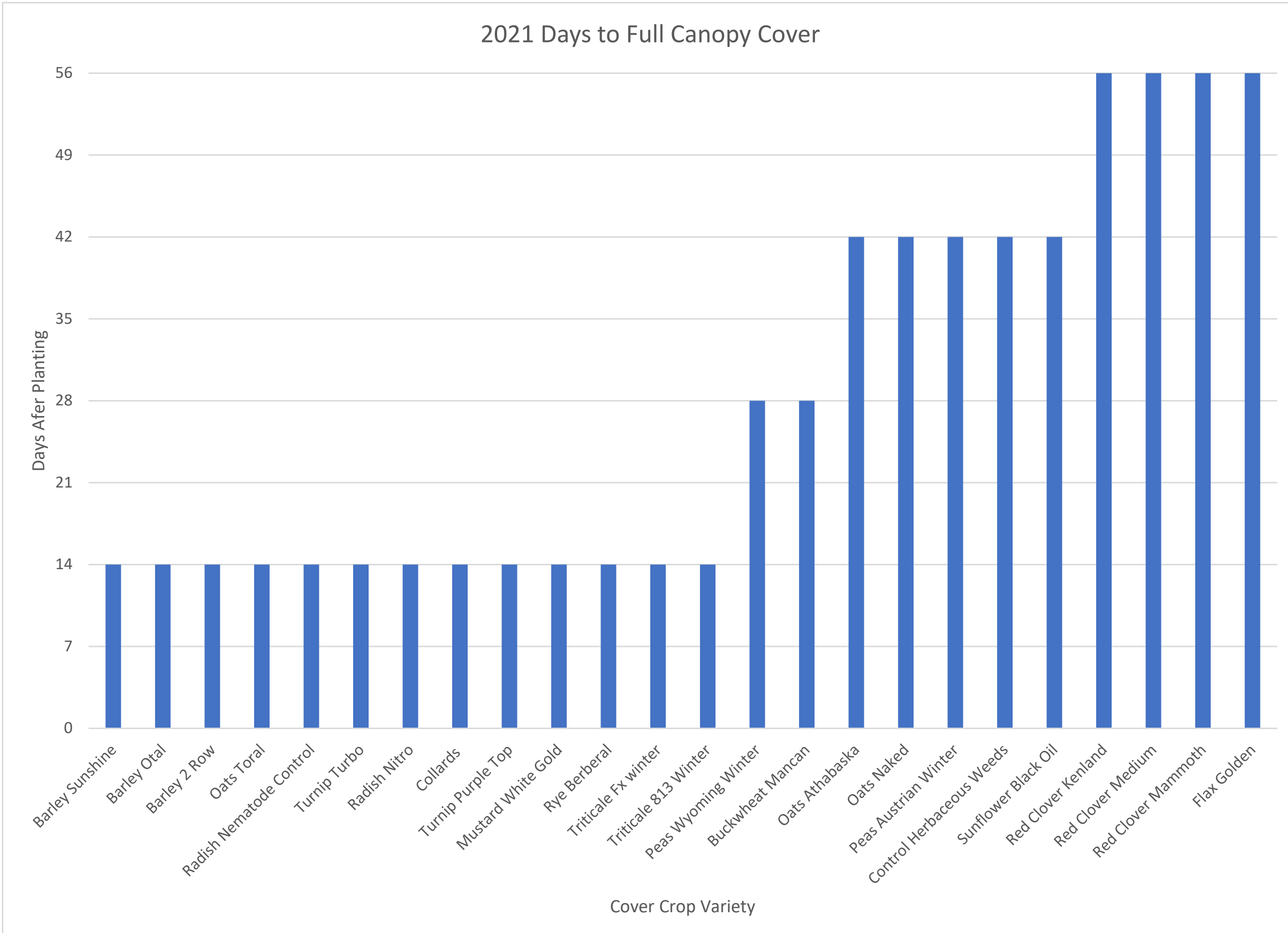

Figure 10. Time (days after planting) to full canopy cover (81-100%) of cover crop varieties ordered from most rapid (left) to slowest (right) in Fairbanks, Alaska, 2021.

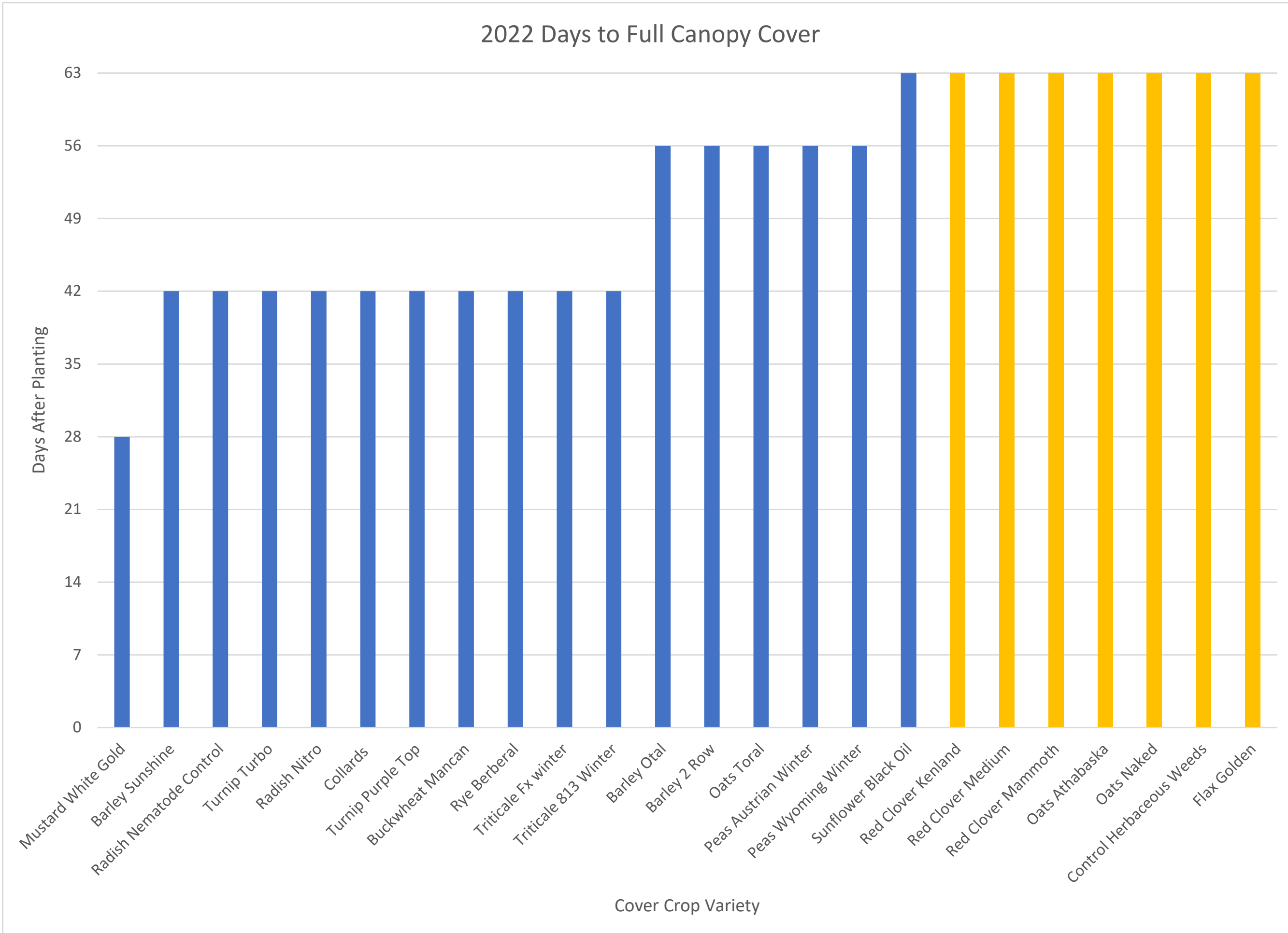

Figure 11. Time (days after planting) to full canopy cover (81-100%) of cover crop varieties ordered from most rapid (left) to slowest (right) in Fairbanks, Alaska, 2022. The yellow bars indicate varieties that did not fully cover bare soil at 63 days after planting.

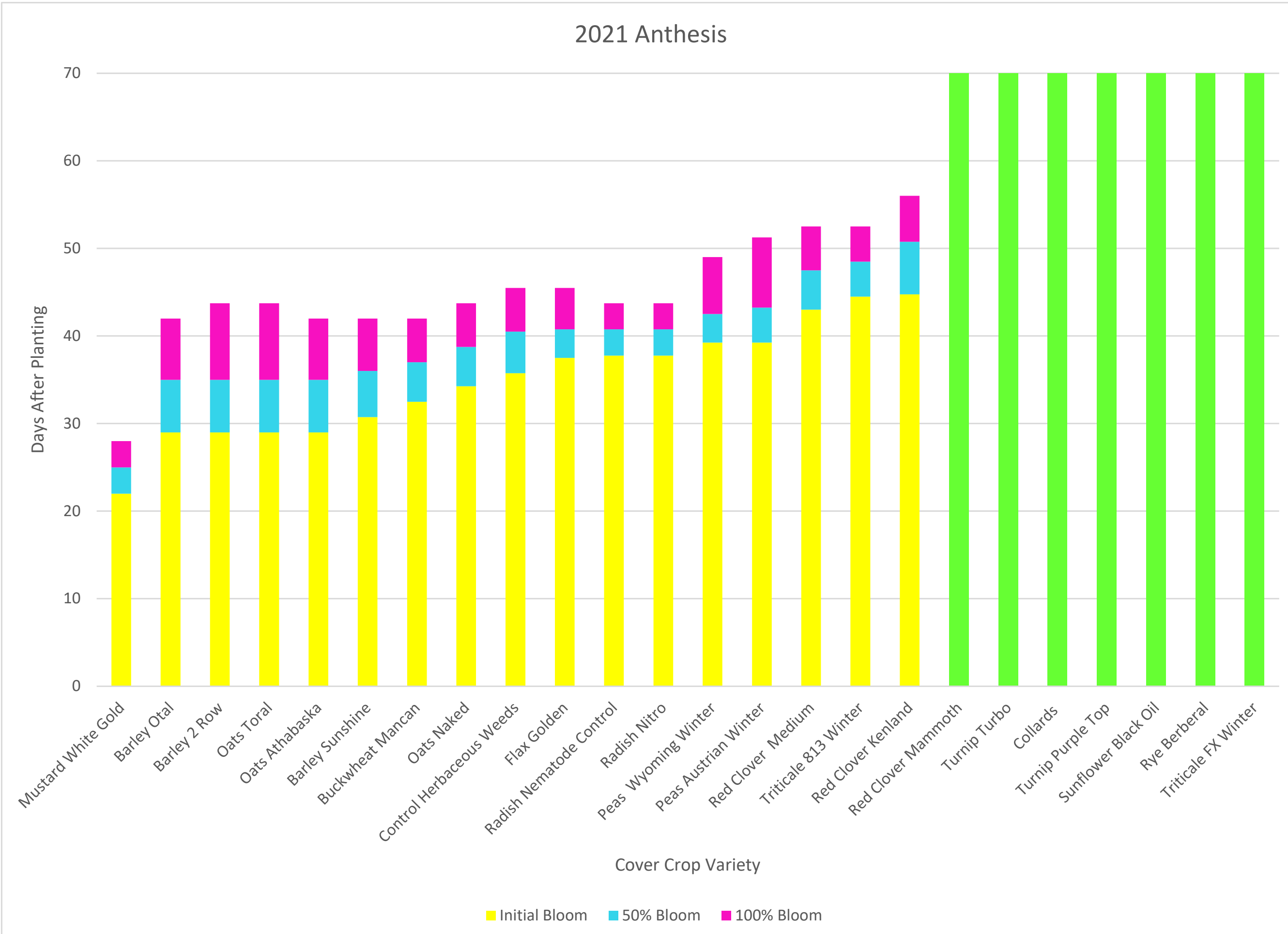

Figure 12. Time (days after planting) to initial bloom (yellow), 50% bloom (blue), and 100% bloom (magenta) ordered by earliest initial bloom in Fairbanks, Alaska, 2021. Green varieties did not bloom.

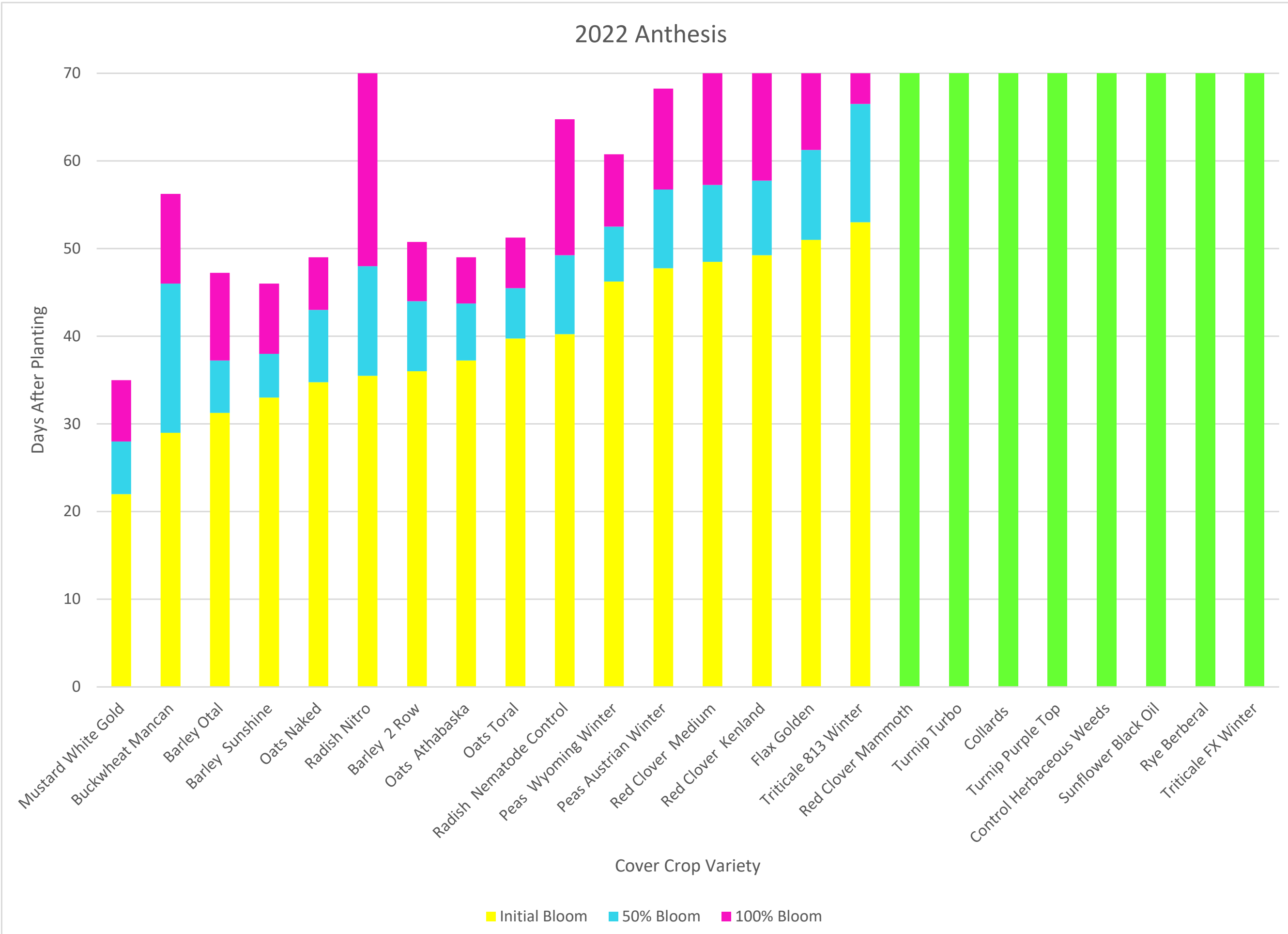

Figure 13. Time (days after planting) to initial bloom (yellow), 50% bloom (blue), and 100% bloom (magenta) ordered by earliest initial bloom in Fairbanks, Alaska, 2022. Green varieties did not bloom.

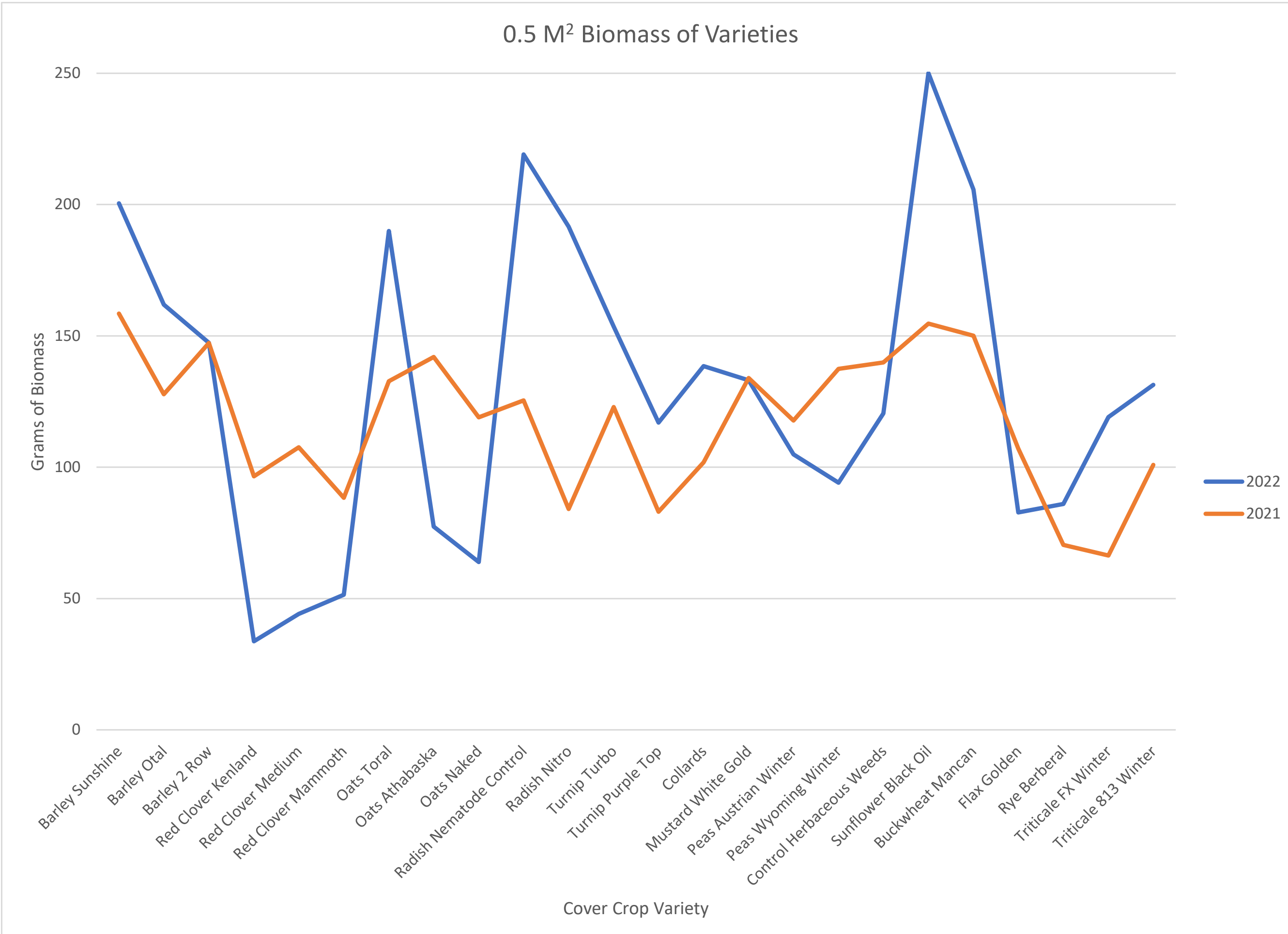

Figure 14. Comparison of sampled biomass weights of cover crop varieties between 2022 and 2021 planted in Fairbanks, Alaska, 2021-2022.

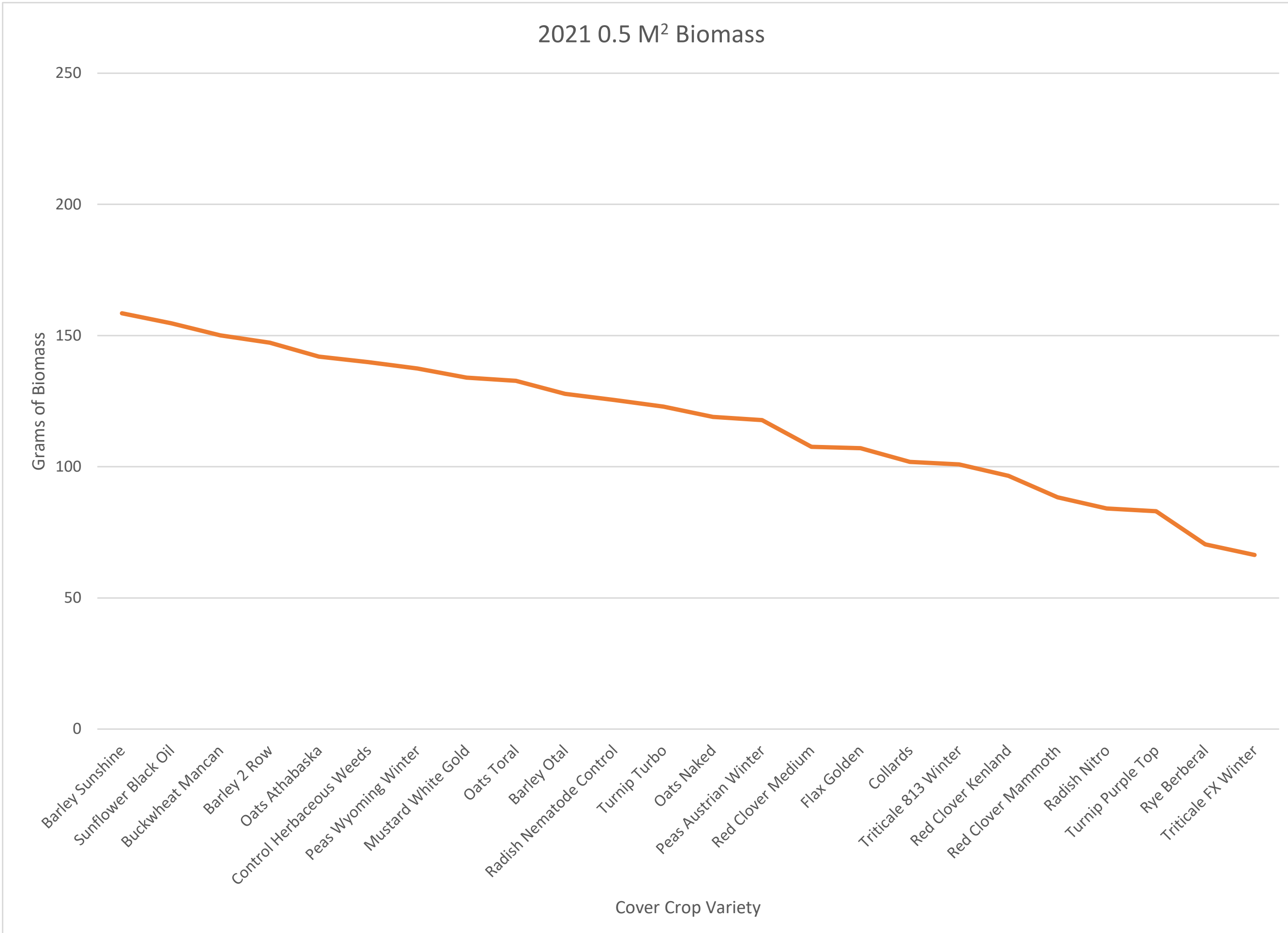

Figure 15. Ordered biomass weight samples for cover crop varieties planted in Fairbanks, Alaska, 2021.

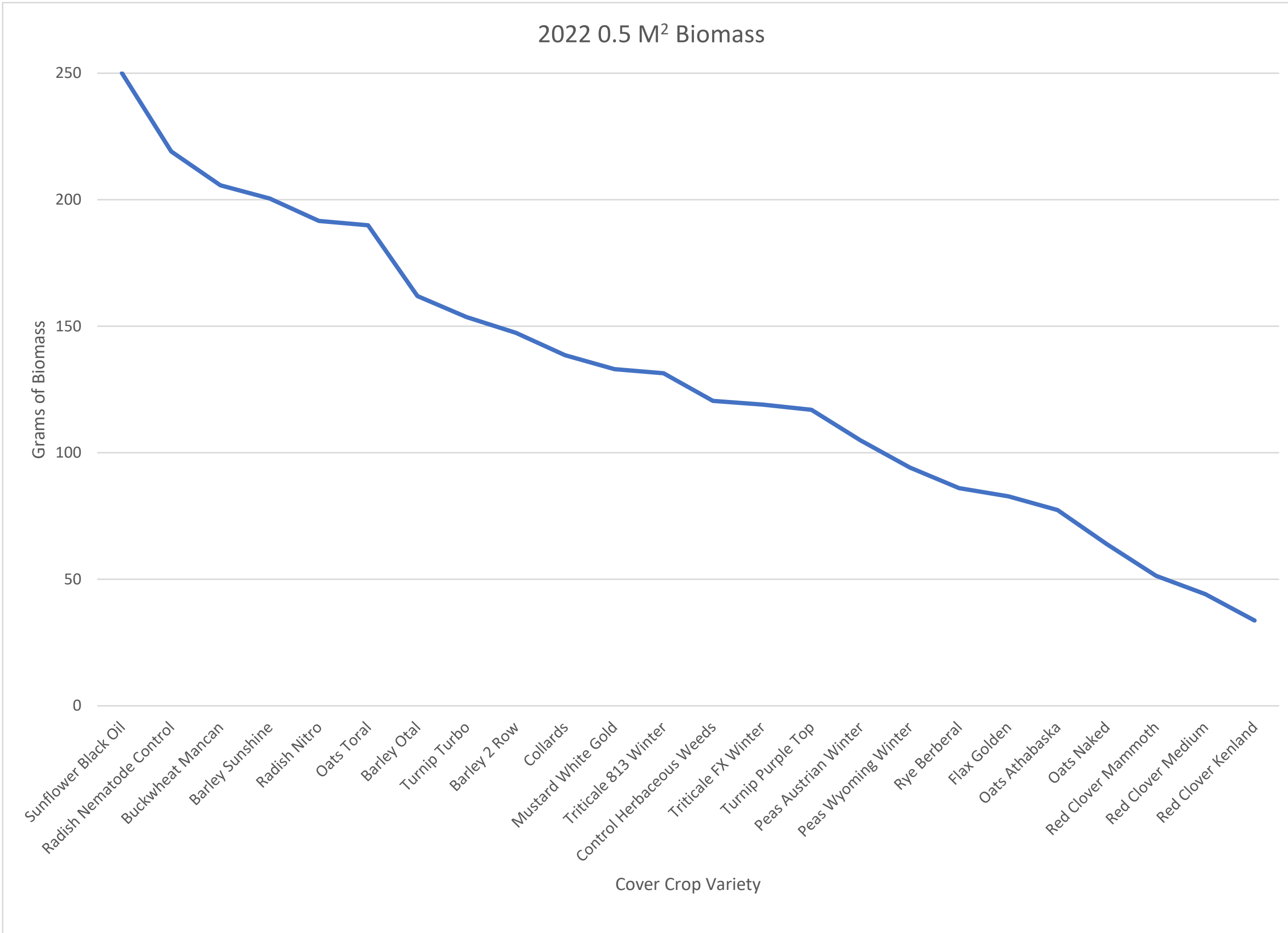

Figure 16. Ordered biomass weight samples for cover crop varieties planted in Fairbanks, Alaska, 2022.

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Appendix A Cover Crop Varieties

Table A1. Cover crop varieties and seeding rate in pounds per acre and 10’ x 25’ plot planted in Fairbanks, Alaska, 2021-2022.

Family	Functional Group	Common Name	Species	Variety	Seeding Rate*
Poaceae (grass)	Grain	Barley	*Hordeum vulgare*	Sunshine	187.2/1.08
Poaceae (grass)	Grain	Barley	*Hordeum vulgare*	Otal	187.2/1.08
Poaceae (grass)	Grain	Barley	*Hordeum vulgare*	2 Row	187.2/1.08
Fabaceae (bean and pea)	Legume	Red Clover	*Trifolium pratense*	Kenland	23.4/0.14
Fabaceae (bean and pea)	Legume	Red Clover	*Trifolium pratense*	Medium	23.4/0.14
Fabaceae (bean and pea)	Legume	Red Clover	*Trifolium pratense*	Mammoth	23.4/0.14
Poaceae (grass)	Grain	Oats	*Avena sativa*	Toral	187.2/1.08
Poaceae (grass)	Grain	Oats	*Avena sativa*	Athabaska	187.2/1.08
Poaceae (grass)	Grain	Oats	*Avena sativa*	Naked	187.2/1.08
Brassicaceae (mustard)	Oilseed/Tillage Radish	Radish	*Raphanus sativus*	Nematode Control	14.04/0.08
Brassicaceae (mustard)	Oilseed/Tillage Radish	Radish	*Raphanus sativus*	Nitro	14.04/0.08
Brassicaceae (mustard)	Turnips	Turnip	*Brassica rapa*	Turbo	14.04/0.08
Brassicaceae (mustard)	Turnips	Turnip	*Brassica rapa*	Purple Top	14.04/0.08
Brassicaceae (mustard)	Collards	Collards	*Brassica oleracea*	-	14.04/0.08
Brassicaceae (mustard)	Mustard	Mustard	*Sinapis alba*	White Gold	14.04/0.08
Fabaceae (bean and pea)	Legume	Field Peas	*Pisum sativum subs. Arvense*	Austrian Winter	195/1.12
Fabaceae (bean and pea)	Legume	Field Peas	*Pisum sativum*	Wyoming Winter	195/1.12
Asteraceae (daisy)	Forb	Sunflower	*Helianthus annum*	Black Oil	24/0.14
Polygonaceae (knotweed)	Forb	Buckwheat	*Fagopyrum esculentum*	Mancan	93.6/0.54
Linaceae (flowering plant)	Forb	Flax	*Linum usitatissimum*	Golden	78/0.45
Poaceae (grass)	Grain	Winter Cereal Rye	*Secale cereale*	Berberal	202.8/1.17
Poaceae (grass)	Grain	Triticale	*X tritosecale*	FX Winter	156/0.9
Poaceae (grass)	Grain	Triticale	*X tritosecale*	813 Winter	156/0.9

***pounds per acre/pounds per 10’ x 25’ plot**

Appendix B Soil Sample Results

Table B1. Soil sample results for the variety trial plot location in Fairbanks, Alaska, 2021-2022.

lb/A

BROOKSIDE LABORATORIES, INC. 44880-436

SOIL AUDIT AND INVENTORY REPORT

Name Fairbanks Soil and Water City Fairbanks State AK

Independent Consultant Home Office Date 06/03/2021

Sample Location UAF	EX				
Sample Identification	FARM				
Lab Number	0719-1				
Total Exchange Capacity (ME/100 g)	14.03				
pH Buffer (SMP/Sikora)	NA				
pH H_2O (1:1)	7.1				
Organic Matter (360°C LOI) %	16.84				
Estimated Nitrogen Release lb/A	128				
SOLUBLE SULFUR* ppm	5				
MEHLICH III lb/A P as P_2O_5	183				
MEHLICH III ppm of P	40				
BRAY II lb/A P as P_2O_5					
BRAY II ppm of P					
OLSEN lb/A P as P_2O_5					
OLSEN ppm of P					
CALCIUM* lb/A	3998				
CALCIUM* ppm	1999				
MAGNESIUM* lb/A	766				
MAGNESIUM* ppm	383				
POTASSIUM* lb/A	60				
POTASSIUM* ppm	30				
SODIUM* lb/A	76				
SODIUM* ppm	38				
BASE SATURATION PERCENT					
Calcium %	71.24				
Magnesium %	22.75				
Potassium %	0.55				
Sodium %	1.18				
Other Bases %	4.30				
Hydrogen %	0.00				
EXTRACTABLE MINORS					
Boron* (ppm)	0.33				
Iron* (ppm)	258				
Manganese* (ppm)	17				
Copper* (ppm)	2.84				
Zinc* (ppm)	1.31				
Aluminum* (ppm)	579				
Soluble Salts (mmhos/cm)					
Chlorides (ppm)					
NO_3-N (ppm)	6.0				
NH_4-N (ppm)	< 0.5				

* Mehlich III Extractable

Appendix C Cover Crop Selector

Table C1. Value of cover crop varieties under different planting objectives.

Cover Crop Variety	Nitrogen Fixation 🔄	Weed Suppression (Emergence) 🌱	Forage (Biomass & 50% Anthesis) 🐄	Erosion (Canopy Cover) 🍃	Soil Compaction ⛏	Pollinators 🐝	Interseeded Rows ⊞	Least Invasiveness ♻	Prior to Cash Crop (Biomass) ⚙
Barley Sunshine		🌱🌱🌱	🐄🐄	🍃🍃🍃🍃				♻	⚙⚙⚙⚙
Barley Otal		🌱🌱🌱	🐄🐄🐄	🍃🍃🍃				♻	
Barley 2 Row			🐄🐄🐄🐄	🍃🍃🍃				♻	⚙⚙⚙
Red Clover Kenland	🔄🔄					🐝	⊞⊞		
Red Clover Medium	🔄🔄					🐝	⊞⊞		
Red Clover Mammoth	🔄🔄								
Oats Toral				🍃🍃🍃				♻	
Oats Athabaska								♻	⚙⚙⚙
Oats Naked								♻	
Radish Nematode Control				🍃🍃🍃🍃	⛏	🐝🐝🐝			⚙⚙⚙
Radish Nitro			🐄🐄🐄🐄	🍃🍃🍃🍃	⛏⛏	🐝🐝🐝			⚙⚙⚙
Turnip Turbo		🌱🌱🌱🌱		🍃🍃🍃🍃	⛏⛏			♻♻♻	
Turnip Purple Top		🌱🌱🌱		🍃🍃🍃🍃	⛏⛏			♻♻♻	
Collards				🍃🍃🍃🍃				♻♻♻	
Mustard White Gold		🌱🌱🌱		🍃🍃🍃🍃		🐝🐝🐝🐝			
Pea Austrian Winter	🔄🔄🔄🔄							♻♻	
Pea Wyoming Winter	🔄🔄🔄🔄							♻♻	
Sunflower Black Oil						🐝		♻♻♻	⚙⚙⚙⚙
Buckwheat Mancan		🌱🌱🌱	🐄🐄🐄🐄			🐝🐝🐝			⚙⚙⚙⚙
Flax Golden			⚠			🐝🐝			
Rye Berberal				🍃🍃🍃🍃			⊞⊞⊞		
Triticale FX Winter		🌱🌱🌱	🐄🐄🐄	🍃🍃🍃🍃			⊞⊞⊞	♻♻♻	
Triticale 813 Winter				🍃🍃🍃🍃				♻♻♻	

⚠ Standing green flax should not be grazed as trampling, mastication, and harvesting can release Hydrocyanic Acid (Prussic Acid), which is extremely hazardous and lethal to animals.

Notes: Four icons mean the variety was a strong contender in both years. Three icons means the variety was a strong contender in one year but not the other. Two icons means it was a medium contender in one or both years. One icon means local knowledge of a variety suiting a purpose.