United States Department of Agriculture
NATURAL RESOURCES CONSERVATION SERVICE
Plant Materials Technical Note No. MT-123
April 2020

PLANT MATERIALS TECHNICAL NOTE

EVALUATION OF COOL SEASON COVER CROP SPECIES IN SOUTHERN MONTANA

M. Pokorny, S. Filbey, R. Kilian, J. Scianna, and J. Jacobs*

Figure 1. National Cover Crop Variety Adaption study at Bridger Plant Materials, July 2017.

INTRODUCTION

Cool season annuals provide multiple benefits to production agriculture when planted as a cover crop such as weed suppression, reducing soil erosion, adding nitrogen, increasing soil organic matter and other soil health improvements, and pollinator habitat enhancement. Cool season annual legumes can reduce nitrogen inputs of subsequent commodity crops, while non-leguminous cover crops, such as small grains, effectively limit nitrate leaching and soil erosion. However, multiple benefits are not achieved unless the best adapted cultivar(s) are planted that meet the planting objectives (i.e. weed suppression, nitrogen scavenging, reduce soil erosion) and the end-user's expectations. The purpose of this study was to evaluate 58 commercially available cultivars and varieties of eight common annual, cool season species for their adaptation to Montana and Wyoming. Austrian winter pea, balansa clover, black oats, cereal rye, crimson clover, daikon radish, hairy vetch, and red clover were evaluated for field emergence, plant height, days after planting to 50% bloom, disease and insect damage, and aboveground biomass production in 2017 and 2018. This study was part of the National Cover Crop Variety Adaptation Trial that tested the same species and cultivars at 25 Plant Materials Centers throughout the United States.

This Technical Note summaries research findings detailed in the Evaluation of Cool Season Cover Crops Final Study Report located on the Montana and Wyoming Plant Materials website.

* Monica Pokorny, Plant Materials Specialist, USDA-NRCS Bozeman, MT; Shannon Filbey, PMC Big Sky Watershed Corps Member; Robert Kilian, USDA-NRCS PMC Rangeland Specialist (retired), USDA-NRCS Bridger; Joseph Scianna, PMC Manager; USDA-NRCS Bridger Plant Materials Center, Bridger, MT; Jim Jacobs, Plant Materials Specialist (retired), USDA-NRCS Bozeman, MT

SUMMARY

The study was conducted at the USDA-Natural Resources Conservation Service, Bridger Plant Materials Center, Bridger, MT in 2017 and 2018 (Figure 1). Cultivars were seeded in early May of 2017 and 2018 using a single-row seeder with a furrow opener and a packer wheel on 12-inch row spacing. Each cultivar was planted in a 20-foot row and replicated four times each year. No irrigation was applied. Total precipitation from May 1 through September 30 was 5.3 inches in 2017 and 5.1 inches in 2018, compared to the long-term average precipitation for the same time period of 6.9 inches. The average air temperature in all months, except September 2018, was greater than the long-term average for the same time period. Overall, climate conditions during the study were drier and warmer than the long-term averages.

Approximately every seven days in both years, field emergence was estimated in each plot for four weeks after planting using the following rating scale: 0 = poor (<25% emergence), 1 = moderate (30 to 60% emergence), 2 = good (65 to 85% emergence), 3 = excellent 90 to 100% emergence). Average plant height was measured at three random locations in each plot. Bloom period was monitored by noting the date of 50% bloom. Entries were rated for disease and insect damage at the 50% bloom stage where 1 = low damage, 3 = moderate damage, and 5 = severe damage. Aboveground biomass samples were collected for each cultivar at the 50% bloom stage (Table 1).

Cultivars producing at least 0.5 pounds of sample dry matter were analyzed for forage quality criteria including crude protein, total digestible nutrients, relative feed value, and nitrate content. *Crude Protein* is the total amount of protein where higher percent protein is usually associated with higher quality. *Total Digestible Nutrients* is an indicator of the concentration of available energy with higher values indicating higher quality. *Relative Forage Value* is a comparison index reflecting the anticipated performance of animals consuming the forage; a higher number indicates higher quality. *Nitrate* (NO_3) is a form of nitrogen vital for plant growth and development; however, it can be a problem for grazing animals in cover crops. Typically, nitrates accumulate in the lower one third of plants during stressful conditions including drought, hail, lodging, and nutrient deficiencies. Generally, all four of the following conditions must be met before nitrate poisoning from grazing occurs: the cover crop is a monoculture or has very low diversity; nitrogen levels in the soils are high; environmental factors have stressed the stand; and grazing occurs below a stubble height of 6 inches.

Austrian Winter Pea

Austrian winter pea is a desirable cover crop species because it produces large amounts of high-quality forage, interrupts disease and pest cycles, provides nitrogen, improves soil microbe diversity and activity, improves soil aggregation, conserves soil water, and provides economic diversity.

Pea flower. Photo by USDA-ARS.

- Austrian winter pea cultivars were relatively slow to establish in the early season but had “good” to “excellent” emergence thereafter.
- All cultivars had low insect and disease damage ratings.
- ‘Arvica 4010’, ‘Dunn’ and ‘Maxum’ had the greatest height and aboveground biomass production.
- Austrian winter pea cultivars had high quality and relatively consistent forage values.

Balansa Clover

Balansa clover is often used as a cover crop species for nitrogen fixation, high forage production, non-bloating forage, excellent forage quality, improved pollinator habitat, and weed control.

- Balansa clover cultivars only achieved a "moderate" emergence rating during the study.
- Both cultivars had low insect and disease damage ratings.
- Both cultivars were small-statured (6-inch average height) and neither produced adequate biomass for forage quality testing.
- Balansa clover may not be well suited for use in Montana and Wyoming.

Black Oats / Black Seeded Oats

Black oat is an upright, winter annual grass used as a cool season, rotational cover crop. It produces large amounts of aboveground biomass for weed control, erosion prevention, green manure, and forage production.

- Both cultivars were relatively slow to establish, requiring 14 to 21 days to reach "good" emergence.
- Both cultivars had consistent overall growth between the two years averaging 53 inches in height and producing similar amounts of good quality forage.
- Both cultivars had moderate insect damage and low disease damage ratings.

Black oat seeds, Photo by USDA-AMS.

Cereal Rye

Cereal rye is an upright, cool season, annual grass that is drought tolerant. As a cover crop, cereal rye can reduce compaction, prevent erosion, provide soil organic matter, provide good quality forage, suppress weeds, and absorb unused soil nitrogen.

- Cereal rye cultivars had "good" to "excellent" emergence ratings within 14 days after planting.
- Cereal rye cultivars varied in height (averaged 36 ± 17 inches) but the aboveground biomass production was relatively consistent and averaged 5218 ± 588 lb/ac for all cultivars.
- Cereal rye cultivars had low to moderate insect damage ratings and low disease ratings.
- Cereal rye averaged 121 relative forage value, 25% protein, and 2.7% nitrate. Care should be taken to minimize potential nitrate impacts to livestock.
- Prevent seed production to avoid cereal rye becoming a weed problem.

Flowering cereal rye in a cover crop plot, Photo by USDA-MOPMC.

Crimson Clover

Crimson clover is used as a cover crop for weed suppression, green manure, and nutritious forage for livestock, wildlife, and pollinators.

- Field emergence was extremely slow for crimson clover cultivars.
- All cultivars were relatively short-statured, producing low amounts of aboveground biomass, and did not reach 50% bloom stage until 73 days after planting.
- All cultivars had low to moderate insect damage and low disease damage ratings.
- If crimson clover is desired for use in Montana or Wyoming, then 'Kentucky Pride' and 'Dixie' cultivars should be selected.

Flowering crimson clover, Photo by USDA.

Daikon Radish

Daikon radish is used as a cover crop to maintain soil quality, fertility, and productivity, reduce soil compaction, scavenge soil nitrogen, and suppress weeds and pests.

- Daikon radish cultivars consistently had "good" to "excellent" field emergence within 14 to 21 days, except for 'Graza' which performed poorly throughout the study.
- Daikon radish cultivars had insect damage in the majority of its leaves but exhibited low disease damage for all cultivars.
- Overall, daikon radish cultivars averaged 42 ± 12 inches height and produced an average of 4010 ± 1864 lb/ac aboveground biomass.
- All daikon radish cultivars provided good forage quality with an average of 30% crude protein and 190% relative feed value.
- Nitrate averaged 5.3 ± 1.0% which was the highest of any species tested in this trial. Care should be taken to minimize potential nitrate impacts to livestock.

Hairy Vetch

Hairy vetch is used as a cover crop for its ability to fix large quantities of nitrogen, provide heavy mulch/biomass for soil and water conservation, and provide good quality forage for livestock. This species may become weedy in some habitats.

- Hairy vetch cultivars had "good" field emergence within 14 to 21 days.
- Plant height varied among cultivars and averaged 19 ± 3 inches.
- Mean days after planting to 50% bloom was relatively consistent among cultivars in both years, except for 'TNT' and 'Villana' which reached 50% bloom approximately 30 days later than other cultivars.
- Insect and disease damage ratings were low for all cultivars.
- Hairy vetch cultivars produced high amounts of aboveground biomass, averaging 3890 ± 2424 lb/ac.
- Hairy vetch had high-quality forage averaging 35 ± 5% crude protein and 181 ± 16 relative feed value.

Flowering hairy vetch, Photo USDA.

Red Clover

Red clover is commonly used for forage production, soil improvement, nitrogen fixation, green manure, and pollinator habitat enhancement. It is also used for preventing soil erosion, competing with weeds, and reducing soil compaction.

Red clover flower, Photo by USDA Plants.

- Red clover cultivars were slow to emerge.
- Cultivars attained a mean plant height 16 ± 4 inches and produced an average of 1339 ± 211 lb/ac aboveground biomass.
- Insect and disease ratings were low to moderate for all cultivars.
- Red clover cultivars averaged 24 ± 1% crude protein and had a relative feed value of 214 ± 23%.

Table 1. Species, cultivars, and seeding rates of 58 annual cool season cover crops evaluated for average plant height, aboveground biomass, and forage quality in 2017 and 2018 at the USDA-NRCS Bridger Plant Materials Center, Bridger, MT. Based on the study results, cover crop cultivar recommendations for Montana and Wyoming are illustrated as green = recommended, yellow = recommended for some cover crop applications, and red not recommended.

Common Name	Species	Cultivar	PLS (lb/acre)	Plant Height (inch)	Biomass (lb/ac)	Crude Protein (%)	Total Digestible Nutrients (%)	Relative Forage Value	Nitrate (%)
Austrian winter pea	*Pisum sativum*	Arvica 4010	10	41	3328	30	77	246	0.2
Austrian winter pea	*Pisum sativum*	Dunn	10	37	3042	21	80	253	0.5
Austrian winter pea	*Pisum sativum*	Frost Master	10	32	2283	32	78	301	0.1
Austrian winter pea	*Pisum sativum*	Lynx	10	19	911	-	-	-	-
Austrian winter pea	*Pisum sativum*	Maxum	10	36	3690	23	77	241	0.2
Austrian winter pea	*Pisum sativum*	Whistler	10	25	2019	34	75	238	0.7
Austrian winter pea	*Pisum sativum*	Windham	10	20	1413	-	-	-	-
Balansa clover	*Trifolium michelianum*	Fixation	20	10	717	-	-	-	-
Balansa clover	*Trifolium michelianum*	Frontier	20	4	181	-	-	-	-
Black seeded oats	*Avena sativa*	Cosaque	20	42	7071	22	68	116	2.1
Black oats	*Avena strigosa*	Soil Saver	20	63	6543	22	66	107	2.0
Cereal Rye	*Secale cereale*	Aroostook	20	23	5418	28	72	119	3.5
Cereal Rye	*Secale cereale*	Bates	20	53	5520	21	72	128	1.6
Cereal Rye	*Secale cereale*	Brasetto	20	18	5371	23	70	118	2.5
Cereal Rye	*Secale cereale*	Elbon	20	34	5333	34	74	142	3.0
Cereal Rye	*Secale cereale*	FL 401	20	63	5662	16	64	104	0.9
Cereal Rye	*Secale cereale*	Guardian	20	18	5528	22	66	108	1.7
Cereal Rye	*Secale cereale*	Hazlet	20	18	5767	18	71	115	0.7
Cereal Rye	*Secale cereale*	Maton	20	39	5225	24	70	126	2.0
Cereal Rye	*Secale cereale*	Maton II	20	46	4483	26	71	129	3.3
Cereal Rye	*Secale cereale*	Merced	20	51	3487	18	63	99	1.7
Cereal Rye	Secale cereale	Oklon	20	35	5003	28	7	124	4.3
Cereal Rye	Secale cereale	Rymin	20	8	5756	23	69	112	2.2
Cereal Rye	Secale cereale	Wheeler	20	26	4928	29	71	128	4.5
Cereal Rye	Secale cereale	WinterGrazer 70	20	52	5222	29	72	127	4.6
Cereal Rye	Secale cereale	Wren's Abruzzi	20	54	5571	32	70	129	4.7
Crimson clover	*Trifolium incarnatum*	AU Robin	20	13	1078	-	-	-	-
Crimson clover	*Trifolium incarnatum*	AU Sunrise	20	12	863	-	-	-	-
Crimson clover	*Trifolium incarnatum*	AU Sunup	20	7	409	-	-	-	-
Crimson clover	*Trifolium incarnatum*	Contea	20	9	746	-	-	-	-
Crimson clover	*Trifolium incarnatum*	Dixie	20	13	1350	26	79	221	1.4

Common Name	Species	Cultivar	PLS (lb/acre)	Plant Height (inch)	Biomass (lb/ac)	Crude Protein (%)	Total Digestible Nutrients (%)	Relative Forage Value	Nitrate (%)
Crimson clover	*Trifolium incarnatum*	KY Pride	20	13	1641	27	79	220	1.5
Daikon radish	*Raphanus sativus*	Big Dog	10	45	4013	32	67	170	5.1
Daikon radish	*Raphanus sativus*	Concorde	10	48	5748	30	70	215	6.0
Daikon radish	*Raphanus sativus*	Control	10	48	7246	29	69	189	5.3
Daikon radish	*Raphanus sativus*	Defender	10	48	7398	26	63	166	4.0
Daikon radish	*Raphanus sativus*	Driller	10	42	3220	33	71	234	5.6
Daikon radish	Raphanus sativus	Eco-till	10	45	3558	32	64	159	5.3
Daikon radish	*Raphanus sativus*	Graza	10	5	1226	-	-	-	-
Daikon radish	Raphanus sativus	Groundhog	10	44	3545	31	68	185	5.2
Daikon radish	*Raphanus sativus*	Lunch	10	42	2539	33	68	211	7.5
Daikon radish	*Raphanus sativus*	Nitro	10	43	3174	33	70	205	6.2
Daikon radish	*Raphanus sativus*	Sodbuster Blend	10	41	2810	26	66	169	4.5
Daikon radish	*Raphanus sativus*	Tillage	10	40	3646	28	70	192	3.8
Hairy vetch	*Vicia villosa*	Groff	10	18	1439	43	71	196	0.5
Hairy vetch	*Vicia villosa*	Lana	10	23	4760	37	71	164	1.2
Hairy vetch	*Vicia villosa*	Purple Bounty	10	20	1851	34	72	170	0.8
Hairy vetch	*Vicia villosa*	Purple Prosperity	10	18	2071	36	69	189	0.4
Hairy vetch	*Vicia villosa*	TNT	10	17	6180	35	72	200	0.5
Hairy vetch	*Vicia villosa*	Villana	10	17	7038	27	69	164	0.3
Red clover	*Trifolium pratense*	Cinnamon Plus	20	16	1555	22	77	254	0.2
Red clover	*Trifolium pratense*	Cyclone II	20	17	1471	25	75	228	0.7
Red clover	*Trifolium pratense*	Dynamite	20	21	1361	25	70	192	1.6
Red clover	*Trifolium pratense*	Freedom	20	16	1350	24	75	201	0.3
Red clover	*Trifolium pratense*	Kenland	20	16	1128	22	74	203	0.7
Red clover	*Trifolium pratense*	Mammoth	20	7	1291	-	-	-	-
Red clover	*Trifolium pratense*	Starfire	20	13	967	-	-	-	-
Red clover	*Trifolium pratense*	Wildcat	20	18	1590	23	75	203	0.3