BRASSICA COVER CROP VARIETY TRIAL

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Introduction

Cover crops can directly benefit farmers by improving soil health and water holding capacity; suppressing weeds, pests, and diseases; preventing erosion and nutrient losses; fixing nitrogen; and providing additional forage for livestock. In Malheur County, Oregon, there is growing interest in cover crops, but little work has been done to identify which cover crops are best suited to this area. This trial evaluated the performance of brassica cover crop species and varieties planted in August 2019 following wheat harvest. Varieties were evaluated for biomass production, weed suppression, and forage quality.

Materials and Methods

Brassica cover crops were grown on an Owyhee silt loam soil in the fall following wheat harvest in 2019. Wheat stubble was shredded, and the field was disked and irrigated. A soil analysis showed a pH of 8.1, 2.94% organic matter, 3 ppm nitrate-nitrogen (N), 3 ppm ammonium-N, 31 ppm phosphorus (P), 331 ppm potassium, 29 ppm sulfate, 3577 ppm calcium, 345 ppm magnesium, 99 ppm sodium, 7.9 ppm zinc, 1.7 ppm copper, 2 ppm manganese (Mn), 14 ppm iron, and 0.04 ppm boron (B). Fertilizers were broadcast applied based on this soil analysis at rates of 120 lb N/acre, 200 lb elemental sulfur/acre, 6 lb Mn/acre, and 1 lb B/acre. The field was then disked and rototilled, then bedded at 30-inch spacing.

A total of 11 varieties of 6 species of brassica were planted on August 28, 2019. Three of the tested varieties are marketed for pest control (biofumigation and nematode control), while the other eight varieties are forage types. The experiment was a randomized complete block design with four replicates. Seeding rates were determined based on dealer recommendations (Table 1). Plots were 15 ft wide (6 beds) by 40 ft long. A 7-row small plot planter with 7.5-inch row spacing was used for planting. The middle row of the planter was plugged to avoid planting in the furrow, resulting in three rows per bed. Seed was planted at ½-inch depth and drag chains were used to ensure good seed-to-soil contact. The trial was furrow irrigated for 24 hours the day after planting. No additional irrigation was applied, and no herbicides or pesticides were used. By not controlling volunteer wheat and weeds, we were able to evaluate weed suppression.

Biomass samples were collected on October 15, 2019, (blocks 1 and 2) and October 16 (blocks 3 and 4). A quadrat measuring 10 ft^2 in area was sampled by cutting all biomass at soil level from a 48-inch-long section of a single bed (30-inch width) within each plot. Four quadrats were sampled in the area surrounding the study to measure weed biomass when no cover crop was present. The fresh weights of the samples were recorded. Two representative subsamples were taken from the original sample. Weeds were removed from the first subsample and the cover crop was sent to Western Laboratories (Parma, ID) for forage quality analysis including percent protein, acid detergent fiber (ADF), and neutral detergent fiber (NDF). The second subsample

was weighed, separated to weed biomass and cover crop biomass, dried, and the dry weights of cover crop and weeds were recorded. Differences between varieties were evaluated using analysis of variance (ANOVA) and means separation was determined using Tukey's honestly significant difference with a family-wise error rate of $P < 0.05$.

Results and Discussion

All varieties emerged by September 3, 2019. The pest control varieties (Master mustard, Control radish, and Caliente 199) were planted at much higher seeding rates than the forage varieties. Unsurprisingly, the pest control varieties reached canopy closure more quickly than the forage types. By September 24, 2019, pest control varieties had fully covered the beds and were largely shading the furrows. Of the forage varieties, Shield mustard had the fullest canopy, fully covering the beds and partially shading the furrows, and Enricher radish, African cabbage and Bayou kale had full coverage of the beds in most plots, followed by Ethiopian cabbage. Winfred forage brassica, purple top rutabaga, and Graza radish had poor stands. It is possible that the 2 lb/acre seeding rates were too low for Winfred and the rutabaga. Local producers have reported good results with Winfred when planted earlier, so it may perform better in warmer parts of the season. Graza was planted from 2-year-old seed which was found to have poor germination, so the results of this trial are likely not representative of this variety.

Cover crop dry biomass ranged from 0.34 ± 0.15 to 1.4 ± 0.23 ton/acre, with biomass production generally following the same pattern as canopy closure (Table 2). The highest yielding varieties were the three pest control varieties and the forage varieties Shield mustard and Bayou kale, and there were no statistically significant differences in yield among these varieties. Ethiopian cabbage and African cabbage had intermediate biomass yields (0.82 ± 0.12 and 0.93 ± 0.10 ton/acre, respectively) that were statistically different from both the highest and lowest yielding varieties. Enricher radish, Graza radish, Winfred forage brassica, and Purpletop rutabaga had average yields of 0.71 ton/acre or less.

Weed and volunteer wheat biomass ranged from 0.05 ± 0.05 ton/acre to 0.61 ± 0.32 ton/acre in cover-crop-planted plots, and averaged 0.80 ton/acre in no-cover-crop check plots. Weed biomass was negatively correlated with cover crop biomass ($P < 0.05$) on a plot-by-plot basis (Figure 1). All varieties except for Purpletop rutabaga had significantly lower weed biomass than the check plots, and most of the varieties had significantly lower weed biomass than Purpletop rutabaga. There was relatively high variability in weed biomass measurements, so sampling methods designed to reduce variability and increased replication would be needed to detect varietal differences in weed suppression.

Many of the cover crop varieties are intended for forage production, often in mixtures with wheat or other cereals. Since volunteer wheat made up the majority of the weed biomass, its contribution to the amount of forage produced should also be considered. The amount of biomass produced by volunteer wheat and weeds in the check plots exceeds the amount of cover crop biomass produced by several of the cover crop varieties. When the total biomass is considered (cover crop biomass + weed biomass), only Control radish, Master mustard, Caliente 199, Shield mustard, Bayou kale, and Ethiopian cabbage produced significantly more biomass than was produced by volunteer wheat.

The cover crops had high forage quality with lower fiber than supreme quality alfalfa and protein content of good quality alfalfa and higher. The protein content of the cover crops ranged from 18.3 ± 1.2% (Enricher radish) to 25.7 ± 2.7% (Winfred forage brassica). Acid detergent fiber ranged from 16.8 ± 1.2 to 21.3 ± 1.3%, and NDF ranged from 29.4 ± 1.7 to 34.3 ± 1.9%, with the exception of Master mustard, which had significantly higher fiber content (26.7 ± 3.6% ADF and 39.7 ± 2.6% NDF).

Conclusions

Brassica cover crops were able to produce up to 1.4 dry ton/acre of high quality forage when planted the last week of August. There is likely room to increase production by optimizing seeding rates, establishment, and planting timing. During an average year, 1070 growing degree units (base 41F) accumulate between August 28 and October 15. Planting 3 weeks earlier would provide the cover crop an additional 650 growing degree units. The late planting date of this study likely limited yield.

Acknowledgements

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Table 1. Brassica varieties included in the cover crop trial and seeding rates used, Malheur Experiment Station, Oregon State University, Ontario, OR 2019. Seeding rates were chosen based on recommendations indicated on suppliers' websites or verbal recommendations from suppliers.

Variety	Seed donor	Seeding rate (lb/acre)
Forage		
Winfred forage brassica	PGG	2
Purpletop rutabaga	Allied Seed	2
Ethiopian cabbage	PGG	4
African cabbage	Saddle Butte Ag	4
Graza radish	PGG	6
Enricher radish	Saddle Butte Ag	6
Shield mustard	Saddle Butte Ag	6
Bayou kale	Saddle Butte Ag	6
Pest control		
Master mustard	Allied Seed	20
Caliente 199	Simplot	20
Control radish	Allied Seed	25

Table 2. Forage quality and dry biomass production of brassica cover crop varieties at the Malheur Experiment Station, Oregon State University, Ontario, OR. 2019. Values are mean ± standard deviation (n = 4). Within each column, values with the same letter did not differ significantly according to Tukey's honestly significant difference.

Variety	Protein (%)	Acid detergent fiber (%)	Neutral detergent fiber (%)	Cover crop biomass (ton/acre)	Weed biomass (ton/acre)	Total biomass (ton/acre)
African cabbage	22.4 ± 5.3 ab	20.3 ± 2.2 bc	34.3 ± 1.3 b	0.93 ± 0.10 bc	0.15 ± 0.04 c	1.08 ± 1.08 bcd
Bayou kale	23.8 ± 1.7 ab	18.0 ± 1.1 bc	31.0 ± 1.2 bc	1.03 ± 0.04 ac	0.22 ± 0.09 c	1.25 ± 1.25 ac
Caliente 199	20.4 ± 2.0 ab	21.3 ± 1.3 b	34.3 ± 1.9 b	1.21 ± 0.19 ab	0.05 ± 0.05 c	1.26 ± 1.26 ac
Control radish	19.3 ± 1.4 ab	19.9 ± 1.4 bc	32.8 ± 1.6 bc	1.39 ± 0.10 a	0.15 ± 0.09 c	1.53 ± 1.53 a
Enricher radish	18.3 ± 1.2 b	19.0 ± 0.9 bc	31.5 ± 1.6 bc	0.71 ± 0.07 ce	0.21 ± 0.11 c	0.92 ± 0.92 cd
Ethiopian cabbage	23.3 ± 4.1 ab	20.5 ± 1.3 bc	33.4 ± 2.5 bc	0.82 ± 0.12 cd	0.33 ± 0.21 bc	1.15 ± 1.15 ad
Graza radish	25.5 ± 2.4 ab	18.6 ± 1.0 bc	30.6 ± 1.2 bc	0.52 ± 0.26 de	0.34 ± 0.08 bc	0.86 ± 0.86 cd
Master mustard	19.3 ± 3.5 ab	26.7 ± 3.6 a	39.7 ± 2.6 a	1.40 ± 0.23 a	0.07 ± 0.06 c	1.47 ± 1.47 ab
Purpletop rutabaga	22.8 ± 3.7 ab	16.8 ± 1.2 c	30.8 ± 1.0 bc	0.34 ± 0.15 e	0.61 ± 0.32 ab	0.96 ± 0.96 cd
Shield mustard	19.5 ± 2.7 ab	19.1 ± 1.1 bc	31.7 ± 1.3 bc	1.19 ± 0.18 ab	0.19 ± 0.12 c	1.38 ± 1.38 ab
Winfred forage brassica	25.7 ± 2.7 a	17.0 ± 0.8 c	29.4 ± 1.7 c	0.47 ± 0.05 de	0.35 ± 0.12 bc	0.82 ± 0.82 d
Weedy check					0.80 ± 0.27 a	0.80 ± 0.27 d

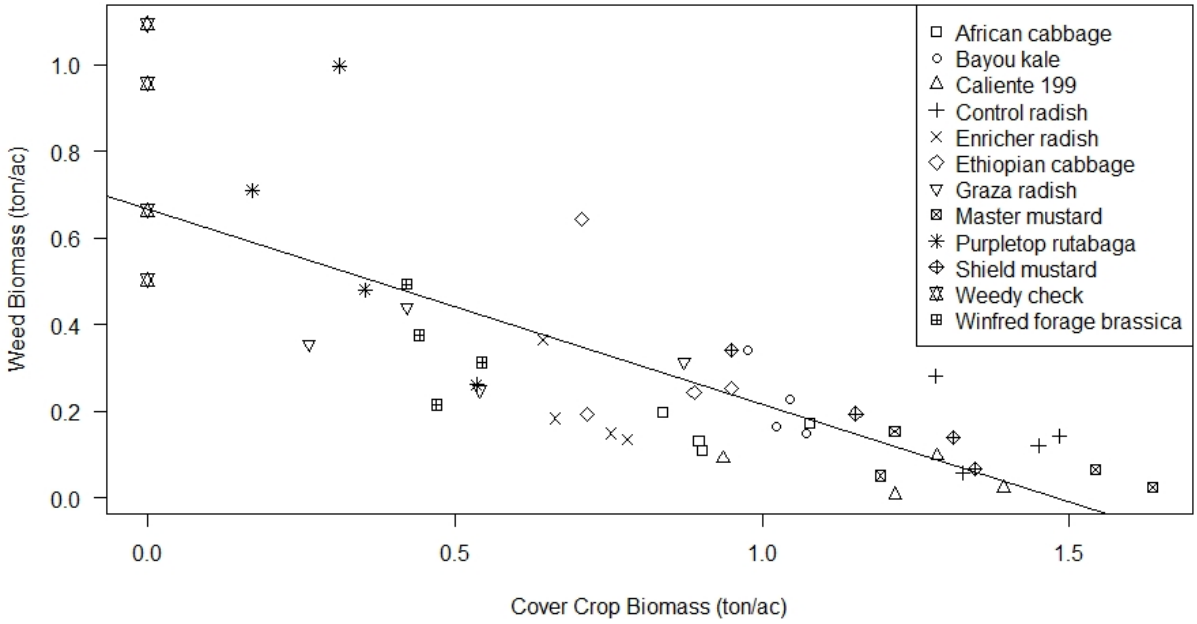

Figure 1. Weed biomass vs. biomass of brassica cover crops for each plot, by cover crop variety, Malheur Experiment Station, Oregon State University, Ontario, OR, 2019. Linear regression analysis (after Box-Cox transformation to meet model assumptions) showed a statistically significant relationship ($P < 0.05$, $r^2 = 0.68$).