EXTENSION
College of Agriculture, Biotechnology & Natural Resources

PEER REVIEWED

FS-25-04

Forage Production Performance of Winter Small Grains in Western Nevada

Juan K. Q. Solomon[1], Akwasi Opoku[1,2], Scott Huber[3], and Gary McCuin[4]

[1]Department of Agriculture, Veterinary & Rangeland Sciences; [2]Graduate Research Assistant, Environmental Science; [3]Experiment Station; [4]Extension Educator

Abstract: This field evaluation focused on assessing the production performance of a sample of varieties among four winter annual small grain species under supplemental irrigation in western Nevada. Such field performance evaluation is critical in helping producers make informed decisions about selecting small grain species and varieties for their farming environment. Based on several similarities in the quantity of biomass produced by the small grains species (cereal rye, oat, triticale and wheat) and varieties evaluated, producers have several options for forage production in western Nevada.

Introduction

Forage remains the principal and cheapest source of feed supply to meet the nutritional requirements of the ruminant livestock industry. Among the many cultivated forage crops, new forage cultivars have significantly improved yield and quality for livestock feeding. However, even within forage species, cultivars differ in their production potential (e.g., yield and quality) under different environmental conditions and agronomic management. Therefore, in any environment, successful forage production requires the selection of highly adapted forage species and cultivars within forage species that can deliver high yield, nutritional value and feeding quality to livestock. Winter small grains forage production is often used to offset shortages in forage feed supply during spring to early summer and will substantially increase the feed inventory for the ruminant livestock industry (e.g., McCormick et al., 2006). These winter small grains grown as a forage crop offer a critical source of protein, energy and minerals in regions of low forage supply (Islam et al., 2013).

Forage crop and cultivar selection is a critical management decision producers must make to optimize forage yield and quality (Darapuneni et al., 2017). However, in today's forage market, numerous cultivars are available, and as such, forage varietal evaluation is a much-needed tool in assessing forage cultivars for production performance in specific environments. Localized forage variety performance data will assist producers in making decisions on which forage species and cultivars to use.

This forage varietal evaluation focuses on four of the major winter small grains cultivated for forage. They are cereal rye (*Secale cereale* L.), oat (*Avena sativa* L.), triticale [×*Triticosecale* Wittm. ex A. Camus. (*Secale* × *Triticum*)] and winter wheat (*Triticum aestivum* L.) that are typically used as hay, greenchop, silage, and in many instances, grazing. This single-location field evaluation of a sample of varieties from the four winter small grains in western Nevada offers a guide to their production performance (yield and quality) under supplemental irrigation.

Materials and Methods

Study location

This winter annual small grains field evaluations were conducted at the Main Station Field Laboratory in Reno, Nevada, from fall 2022 to spring 2023 and from fall 2023 to spring 2024. Soil at the experimental sites was a Truckee silt loam soil. Soil test results of the experimental plot areas at the 0 to 6-inch depth before seeding are displayed in Table 1. Total precipitation at the experimental site from October to May was 11.95 inches and 2.69 inches during the 2022 to 2023 and 2023 to 2024 growing seasons, respectively.

Table 1. Initial soil analysis at the two different plot areas in the fall of 2022 and 2023.

Soil parameter	2022	2023
pH	7.2	7.4
Organic matter (%)	4.2	5.2
Cation Exchange Capacity (CEC) (meq/100 g)	19.9	26
Nitrate-Nitrogen (NO_3-N) (mg/kg)	10.2	23
Phosphorus (P) (mg/kg)	30.4	49.7
Potassium (K) (mg/kg)	259	715
Magnesium (Mg) (mg/kg)	575	783
Calcium (Ca) (mg/kg)	2696	3319
Sodium (Na) (mg/kg)	218	247
Sulfur (S) (mg/kg)	31	21
Zinc (Zn) (mg/kg)	2.24	2.11
Iron (Fe) (mg/kg)	28.1	21.4
Manganese (Mn) (mg/kg)	23.9	4.7
Copper (Cu) (mg/kg)	2.32	1.56

Unit Conversion: 1 mg/kg soil = 1 ppm.

Experimental design and small grains information

In the fall each year, six and eight varieties from four and three winter small grains forage species, respectively (Table 2), were seeded into a prepared seedbed during the first week of October using the recommended seeding rate in Table 2. Each year, the varieties were laid out in a randomized complete block experimental design with three replications for each variety. The plot size used in this field evaluation measured 15 feet long by 5 feet wide and was separated by a 5-foot alleyway between plots and 20 feet between blocks. Plots were seeded using a Wintersteiger Plotseed XL seeder in rows 8 inches apart.

Table 2. Forage winter small grains species and varieties used for the two growing seasons at the Main Station Field Laboratory, Reno, Nevada.

Small grains	Variety	Small grains	Variety	Seeding rate
2022 - 2023	2022 -2023	2023 -2024	2023 -2024	(lb PLS/ac)
Oat	Goliath	Rye	Elbon	100
Cereal rye	Elbon	Triticale	Surge	100
Cereal rye	Rymin	Triticale	Flex	100
Triticale	Trical 348	Triticale	Kicker	100
Triticale	SY TF 813	Triticale	Motley	100
Wheat	Brundage	Triticale	Gunner	100
		Wheat	Bundrage	100
		Wheat	Stormbreaker	100

Table information: PLS, pure live seed. This is just a sample of the many commercially available varieties on the market. This is not a comprehensive list.

Crop management

After sowing in both years (first week of October), two irrigation events were carried out using a solid-set sprinkler system. The first irrigation was applied shortly after sowing, and the second in mid-October. In the spring, four irrigation events were carried out at two-week intervals from April through May each year. The quantity of water applied during irrigation was based on reference evapotranspiration data from a nearby weather station. Total irrigation water applied was 12.7 inches in the 2022 to 2023 growing season and 17.2 inches in the 2023 to 2024 growing season. Based on the soil test recommendation, phosphorus was applied at a rate of 40 pounds P_2O_5/acre (triple superphosphate) two days before sowing. Nitrogen was applied once at 80 pounds/acre (urea) in early April of each year. Postemergence broadleaf weed control during the spring was carried out once using 2,4-dichlorophenoxyactetic acid at an application rate of 1 pt/acre.

Data collection

Plant height (measured from the stem base to the tip of the seedhead) from three random locations in each plot and biomass from an area of 30 square feet in each plot using a forage harvester were collected in the first week of June each year. After weighing and recording the fresh sample from each plot, a subsample (sampled from several areas in the harvested pile) of approximately 500 g was used for dry matter determination and forage nutritive value analysis. The subsamples were oven-dried at 60 C for 72 hours. Biomass yield was calculated on a dry matter basis using the dry matter percentage of each variety. Each subsample was ground separately using a Wiley mill (Model 4, Thomas Scientific, Swedesboro, NJ) to pass a 1mm screen and stored in Whirl-Pak sample bags. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) analyses were done according to the ANKOM procedure. Forage quality indicators for each small grain variety were determined based on the formulas: digestible dry matter (DDM) = 88.9 - (.779 × %ADF), dry matter intake (DMI) = 120 / %NDF, and relative feed value (RFV) = DMI × DDM × 0.775.

Data analysis

Data were analyzed using the General Linear Model (GLM) procedures of SAS version 9.4 (SAS Institute, 2015). Variety means for each measured or estimated parameter were compared statistically using the Least Significant Difference (LSD) test at the probability level of alpha = 0.05. The LSD value for means comparison among each parameter represents the minimum value between any two varieties to determine if the difference was due to variety only.

Results and Discussion

The main focus of this small grains forage evaluation field trial is to help producers in their decision-making when selecting winter annual small grains species and the variety to grow. As such, the focus is on biomass production performance as a guide for the selection of winter small grains, but this evaluation also provides some estimates of forage quality based on the two fiber fractions of acid- (ADF) and neutral detergent fiber (NDF) of these forage species was also provided. In the first year (2022-2023), the forage biomass of the oat variety Goliath was less than that of Elbon cereal rye, Brundage wheat and SY TF 813 triticale (Table 3). No other differences occurred among the small grains species for biomass production (Table 3). Concerning the forage quality estimates (DMI, DDM and RFV), the triticale variety SY TF 813 was consistently ranked among the highest, while Elbon cereal rye was among the lowest for DMI, DDM and RFV (Table 3).

Table 3. Forage production and quality estimates of winter small grains harvested in May 2023 at the Main Station Field Laboratory, Reno, Nevada.

Small grains	Variety	Biomass (Ton/ac)	Plant height (cm)	DM %	ADF %	NDF%	DDM %	DMI	RFV
Cereal rye	Elbon	6.0^{a}	157	47.3^{a}	37.7	62.4^{a}	40.3^{c}	1.9^{c}	60.3^{c}
Wheat	Brundage	5.8^{a}	136	39.2^{b}	46.6	56.2^{bc}	45.2^{ab}	2.1^{ab}	75.0^{ab}
Triticale	SY TF 813	5.3^{a}	130	35.6^{b}	39.7	54.1^{c}	46.8^{a}	2.2^{a}	81.3^{a}
Cereal rye	Rymin	5.1^{ab}	139	41.4^{ab}	37.0	55.6^{bc}	45.5^{ab}	2.1^{ab}	76.3^{ab}
Triticale	Trical 348	4.9^{ab}	149	35.8^{b}	38.9	56.0^{bc}	45.3^{ab}	2.1^{ab}	75.3^{ab}
Oat	Goliath	3.2^{b}	138	26.9^{c}	40.6	59.3^{ab}	42.7^{bc}	2.0^{bc}	67.3^{bc}
Mean		5.1	141	37.7	40.1	57.3	44.3	2.1	72.6
CV%		22.2	17.5	10.4	18.2	4.8	4.8	5.0	10.0
LSD (0.05)		2.0	NS	6.9	NS	5.0	3.8	0.19	13.2

Table information: DM, dry matter; ADF, acid detergent fiber; NDF, neutral detergent fiber; DDM, digestible dry matter; DMI, dry matter intake (% of body weight); RFV, relative feed value; CV, coefficient of variation (a measure of the relative precision of a given trial/amount of unexplained variation in a trial); LSD, Least Significant Difference; NS, not significant. Within columns, means with the same letter superscript are not different ($P > 0.05$).

Table 4. Forage production and quality estimates of winter small grains harvested in May 2024 at the Main Station Field Laboratory, Reno, Nevada.

Small grains	Variety	Biomass (Ton/ac)	Plant height (cm)	DM%	ADF %	NDF %	DDM %	DM% I	RFV
Triticale	Gunner	5.7^{a}	136.7^{ab}	33.3^{bc}	41.6^{ab}	54.9^{ab}	56.5^{bc}	2.2^{b}	95.7^{bcd}
Triticale	Kicker	5.3^{ab}	144.3^{ab}	29.0^{c}	41.9^{ab}	56.2^{a}	56.3^{bc}	2.1^{b}	93.3^{cd}
Triticale	Flex	5.0^{ab}	141.7^{ab}	34.0^{bc}	43.3^{a}	56.4^{a}	55.2^{c}	2.1^{b}	91.0^{d}
Triticale	Surge	4.8^{ab}	142.7^{ab}	31.3^{bc}	41.9^{ab}	56.5^{a}	56.3^{bc}	2.1^{b}	92.7^{cd}
Triticale	Motley	4.2^{ab}	113.3^{cd}	27.3^{c}	43.4^{a}	54.8^{abc}	55.1^{c}	2.2^{ab}	93.7^{cd}
Wheat	Brundage	4.2^{ab}	130.0^{bc}	38.3^{ab}	39.7^{c}	52.4^{bc}	57.9^{a}	2.3^{a}	103^{a}
Cereal rye	Elbon	3.7^{bc}	151.3^{a}	46.0^{a}	41.1^{bc}	52.0^{c}	56.9^{ab}	2.3^{a}	101.7^{ab}
Wheat	Stormbreaker	2.2^{c}	110.3^{d}	39.3^{ab}	40.2^{bc}	54.7^{abc}	57.6^{ab}	2.2^{ab}	98.0^{abc}
Mean		4.4	133.8	34.8	41.6	54.7	56.5	2.2	96.1
CV%		25.3	7.3	13.8	2.5	3.0	1.4	3.1	4.0
LSD (0.05)		1.9	17	8.0	1.8	2.9	1.4	0.12	6.7

Table information: DM, dry matter; ADF, acid detergent fiber; NDF, neutral detergent fiber; DDM, digestible dry matter; DMI, dry matter intake (% of body weight); RFV, relative feed value; CV, coefficient of variation (a measure of the relative precision of a given trial/amount of unexplained variation in a trial); LSD, Least Significant Difference; NS, not significant. Within columns, means with the same letter superscript are not different ($P > 0.05$).

In the second year (2023-2024), the majority of the varieties evaluated produced similar biomass yields (Table 4). However, the wheat variety Stormbreaker produced lower biomass than all other small grain varieties except Elbon cereal rye (Table 4). Also, Elbon cereal rye produced less biomass than Gunner triticale (Table 4). For the forage quality estimates, the two wheat varieties Brundage and Stormbreaker, and the cereal rye Elbon, ranked consistently among the highest in DMI, DDM and RFV (Table 4). Overall, the biomass produced in both years for the winter small grains evaluated in this environment was greater than those reported by Billman et al. (2021) for late-harvest small grains (Cereal rye, Triticale, Winter wheat) in New Hampshire under rainfed conditions. Also, the biomass produced from these small grains was similar to those reported for oat, cereal rye, triticale and wheat in Texas (Darapuneni et al., 2017) but greater than the biomass reported for cereal rye, triticale and wheat in Wyoming (Islam et al., 2013). Among the small grains species evaluated, the ADF values were greater, but NDF values were similar to those reported for triticale in Kansas (Obour et al., 2020). However, the relatively low forage quality estimates of these small grains at the time of harvest may indicate their relative maturity, as Zhao et al. (2021) reported a decrease in total digestible nutrients and relative forage quality (RFQ) from jointing to heading and beyond for cereal rye. To maximize relative forage quality, Vaughn et al. (2024) recommended that winter cereal rye should be harvested during the first week of April to reach the dairy standard RFQ of 150, but at the same time, the winter cereal rye biomass in their study is only 0.34 ton/acre, which will significantly affect producers feed availability and profit margins.

Conclusions and Recommendations

Given the lack of differences among several of the small grain species and varieties in both years, producers have several options of small grain species to use to supplement their feed budget in this environment. If feed quality is the focus of growers, then an earlier spring harvest just at the boot stage compared to the soft or hard dough stage will be required to maximize feed quality, but this approach will often reduce biomass production. In addition, among the small grains, variety-specific harvest timing will be a useful approach to maximize biomass production and quality.

References

Billman, E. D., de Souza, I. A., Smith, R. G., Soder, K. J., Warren, N., Teixeira, F. A., & Brito, A. F. (2021). Winter annual forage mass–nutritive value trade-offs are affected by Harvest Timing. *Crop, Forage & Turfgrass Management*, *7*(2). https://doi.org/10.1002/cft2.20113

Darapuneni, M. K., Morgan, G. D., McKay, B. L., Dodla, S. K., & Lauriault, L. M. (2017). Selecting cool-season forage grasses for yield, seasonal yield distribution, and nutritive value in the Blacklands and Rolling Plains Ecoregions of Texas. *Crop, Forage & Turfgrass Management*, *3*(1), 1–10. https://doi.org/10.2134/cftm2017.04.0031

Islam, M. A., Obour, A. K., Saha, M. C., Nachtman, J. J., Cecil, W. K., & Baumgartner, R. E. (2013). Grain yield, forage yield, and nutritive value of dual-purpose small grains in the Central High Plains of the USA. *Crop Management*, *12*(1), 1–8. https://doi.org/10.1094/cm-2012-0154-rs

McCormick, J. S., Sulc, R. M., Barker, D. J., & Beuerlein, J. E. (2006). Yield and nutritive value of autumn-seeded winter-hardy and winter-sensitive annual forages. *Crop Science*, *46*(5), 1981–1989. https://doi.org/10.2135/cropsci2006.0140

Obour, A. K., Holman, J. D., & Schlegel, A. J. (2020). Spring triticale forage responses to seeding rate and Nitrogen application. *Agrosystems, Geosciences & Environment*, *3*(1). https://doi.org/10.1002/agg2.20053

Vaughn, K., Adeyemi, O., Zandvakili, O. R., Battaglia, M. L., Babaei, S., Nair, J., Still, S., Burkett, G., & Sadeghpour, A. (2024). Nitrogen rate and harvesting time based on growing degree days influenced winter cereal rye morphological traits, forage yield, quality, and farm profit in poorly drained Alfisols. *Grass and Forage Science*, *79*(2), 239–253. https://doi.org/10.1111/gfs.12645

Zhao, G. Q., Wei, S. N., Liu, C., Kim, H. J., & Kim, J. G. (2021). Effect of harvest dates on β-carotene content and forage quality of rye (Secale cereale L.) silage and hay. *Journal of Animal Science and Technology*, *63*(2), 354–366. https://doi.org/10.5187/jast.2021.e28

