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Jamie L. Whitten Plant Materials Center
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Planting and Harvesting Date Effect on Forage Quantity and Quality of Four Cool Season Grass Cover Crops in the Mid-South

Jonathan Vollmer*, Michael Richard, and Jon Allison

ABSTRACT

Annual cool season grass cover crops can provide multiple benefits to production agriculture such as controlling soil erosion, suppressing weeds, and provide winter grazing. However, the success of an annual cool season grass for livestock forage is dependent on choosing the appropriate species, as well as the proper planting and harvest dates to meet the planting objectives. The purpose of this study was to evaluate the performance of four annual cool season grass species based on planting and harvest date combinations for optimizing forage production. Black-seeded oats (*Avena sativa* L.), cereal rye (*Secale cereale* L.), winter wheat (*Triticum aestivum* L.), and winter triticale (*Secale x Triticum* L.) were evaluated at the Jamie L. Whitten Plant Materials Center near Coffeeville, MS in 2021-2022 and 2022-2023 for aboveground dry matter yield, crude protein, total digestible nutrients, acid detergent fiber, neutral detergent fiber, and relative forage quality. To maximize forage quality and quantity of black-seeded oats plant between September 15 and October 15 to achieve a grazing period from March 1 to May 1 with minimal supplementation. Cereal rye planted between September 15 to October 15 produced acceptable dry matter and forage quality from March 1 to April 1; however, forage quality declined if harvested on May 1 and would require significant supplementation. Winter triticale planted between September 15 to October 15 produced adequate forage yield and quality for grazing March 1 to May 1 with minimal supplementation. Winter wheat planted between September 15 to October 15 produced a quality grazing period from March 1 to May 1 with minimal supplementation.

INTRODUCTION

Cool season cover crops have the ability to provide nutritious forage and soil health benefits during the fall and winter months for producers in the southern states (Han et al, 2018). A challenge to integrating cover crops as forage in row crop production is the great variation in cool season cover crops species and how environmental factors such as water availability, soil temperature, and length of growing period effect their growth response (Mirsky et al, 2017). To address the question of cover crop adaptability, plant materials centers nationwide conducted an adaptation trial of small grains, legumes, and forbs to identify potential species and varieties best adapted for cover cropping in the Mid-South (Richard and Allison, 2020). Additionally, the Jamie L. Whitten Plant Materials Center conducted a study to identify planting and termination date windows for four cool season grass species to maximize soil cover, dry matter production, and/or nitrogen scavenging ability (Vollmer et al, 2023). Further characterization of the forage quantity and quality of these four cool season grass cover crop species across various planting and termination dates will maximize cover crop benefits and allow NRCS planners to recommend the most appropriate species and planting/harvesting (i.e. grazing, haying, or ensiling) windows to meet the resource concerns of the producer.

Another challenge to integrating cover crops as a forage in row crop production is timely planting. After planting, cover crops produce biomass in the fall, growth slows during the winter, followed by green up in the spring. Mid-September through mid-October is the ideal time to sow cool season cover crops in the Mid-South. However, many producers still have crops in the ground in September and often perform post-harvest activities into

*Jonathan Vollmer, 2533 CR-65, Coffeeville, Mississippi, 38966; jonathan.vollmer@usda.gov

October which makes cover crop planting difficult. Delayed sowing into November is a risk because of unfavorable weather conditions. Research conducted at the Jamie L. Whitten Plant Materials Center found cool season grass cover crops sown between September 15 to October 15 produced significantly more dry matter when terminated between February 15 to April 1 compared to November 1 and November 15 plantings (Vollmer et al, 2023). However, they also stated that later plantings produced significantly more dry matter when terminated on or after April 15. These results are supported by those reported by Saini et al. (2008) who reported that cereal rye biomass increased with early planting and later termination while also decreasing weed biomass. Understanding the proper planting windows for different winter cereal species will help narrow down the available options for the planner and increase the probability that the cover crop will meet the conservation need.

Economic feasibility is another challenge to integrating cover crops as a forage in row crop production. The potential of yield loss in the subsequent cash crop and expensive forage produced from cover crops can be a major hinderance to the adoption of this practice. Rushing et al. (2023) reported that grazing stocker cattle on oats (*Avena sativa* L.) or an oat and crimson clover (*Trifolium incarnatum* L.) cover crop mix followed by subsequent no-till soybean production had the potential to increase net returns for livestock-row crop producers. They also reported that cover crop species did not impact the following soybean [*Glycine max* (L.) Merr.] grain yield, but they did suggest that cover crop choice impacted net revenue in east-central Mississippi. Additionally, Schomberg et al. (2014) reported that the returns from grazing had the potential to offset the establishment costs of a rye cover crop and increase profits for continuous no-till cotton (*Gossypium hirsutum* L.) in the southern Piedmont of the United States.

Lastly, the decision of when to terminate or harvest cover crops is another important question/concern. Cover crop termination dates are normally determined based on the subsequent cash crop which can sometimes lead to early cover crop termination. Terminating too early can reduce dry matter; however, terminating too late can increase forage maturity resulting in a significant decrease in forage quality. For instance, Kantar et al. (2011) observed cereal rye grazed during the early vegetative stage to boot stage provided high quality pasture in the early spring, but dry matter yields were lower. They also reported forage quality, as measured by crude protein and dry matter digestibility fiber, generally decreased with maturity while forage dry matter increased. There is limited information on the effect of planting and terminate dates on forage production of recommended varieties of cool season annual grasses commonly planted as cover crops in the Mid-South. The purpose of this study is to identify the planting and harvested/grazing windows needed for each of these cover crop species to maximize dry matter production and forage quality to address the producers forage and resource concerns.

MATERIALS AND METHODS

The study was conducted at the USDA-NRCS Jamie L. Whitten Plant Materials Center, Coffeeville, MS from 2021-2023. Treatments consisted of five planting dates: September 15, October 1, October 15, November 1, and November 15 and three termination dates: March 1, April 1, and May 1. Annual, cool season cover crops were planted on a pure live seed basis (Table 1). Varieties of each species were selected based upon cover crop varieties that performed well in a cool season adaption trial previously conducted at the Jamie L. Whitten Plant Materials Center (Richard and Allison, 2020). Prior to planting, a firm, weed-free seedbed was prepared using tillage equipment and non-selective herbicide. The study was conducted on field 11 (Grenada silt loam) in 2021-2022 and field 7 (Grenada silt loam) in 2022-2023 which are enclosed by an 8-foot exclusion fence to prevent deer damage to the cover crops. Plots were drilled with a Kincaid/Great Plains cone drill (Kincaid, Haven, KS). Plot dimensions were 5-ft x 30-ft. No supplemental irrigation was applied. At each planting date soil moisture and air temperature were recorded. Growing Degree Days at 40°F (GDD-40) was calculated from planting to harvest date (Eq. 1). Plant growth stage was recorded at harvest. Plots were harvested using a 0.25 m² frame. Only representative areas of the plot excluding the edge rows were selected for sampling. Samples were dried at 55°C for a minimum of 72 hours or until a constant weight was obtained and weighed to the nearest 0.10 grams. Initial weight was divided by 454 grams to convert weight to pound and round to the nearest 0.01 lbs. Dry matter yields (DMY), total digestible nutrients (TDN), digestible dry matter (DDM), dry matter intake (DMI), and relative feed value (RFV) were calculated using Equation 2-6. Subsamples from replication 1 and 3 biomass harvests were used for forage quality analysis by Mississippi State University forage lab.

Experimental design was a randomized complete block design with a 5 X 3 factorial arrangement with four replications per treatment. Dry matter yields (lb/acre), TDN, DDM, DMI, and RFV were analyzed with analysis of variance (ANOVA) procedure in Statistix 10 (Analytical Software, Tallahassee, FL) and mean separation was performed by Tukey's HSD all pairwise comparison tests at $P<0.05$.

Table 1. Grass species: common name, species, cultivar, and pure live seeding (PLS) rate. USDA-NRCS, Coffeerville, MS 2023.

Common name	Species	Cultivar	PLS (lb/acre)
Black-seeded oat	<i>Avena sativa</i>	Cosaque	60
Cereal rye	<i>Secale cereale</i>	Elbon	100
Winter triticale	<i>Secale x Triticum</i>	SF TF 813	100
Winter wheat	<i>Triticum aestivum</i>	SS 30-06	100

$$\text{Equation 1: GDD} - 40 = \frac{(\text{Min. Daily Temp } (^{\circ}\text{F}) + \text{Max. Daily Temp } (^{\circ}\text{F}))}{2} - 40^{\circ}\text{F}$$

$$\text{Equation 2: Dry matter yield } \left(\frac{\text{lb}}{\text{acre}} \right) = \frac{(\text{Dry sample (lb)} \times 4047 \text{ m}^2)}{0.25 \text{ m}^2}$$

$$\text{Equation 3: \%Total Digestible Nutrients (TDN)} = 58.4 + (1.034 \times \% \text{CP}) - (0.42 \times \% \text{ADF})$$

$$\text{Equation 4: \%Digestible Dry Matter (DDM)} = 88.9 - (0.799 \times \% \text{ADF})$$

$$\text{Equation 5: \%Dry Matter Intake (DMI)} = \frac{120}{\% \text{NDF}}$$

$$\text{Equation 6: Relative Feed Value (RFQ)} = \frac{\text{TDN} \times \text{DMI}}{1.23}$$

RESULTS AND DISCUSSION

Weather data for 2021-2022 and 2022-2023 growing seasons.

Monthly rainfall from September through May in 2021-2022 and 2022-2023 were recorded from an official weather station near the study sites (Fig. 1). Total precipitation from September through May was 41.2 inches in 2021-2022 and 39.2 inches in 2022-2023. In the 2021-2022 season, monthly rainfall in September was 6.24 inches greater than the 2022-2023 season. However, in the 2022-2023 season, monthly rainfall was 2.59 inches and 3.42 inches greater in January and April compared to the 2021-2022 season, respectively (Fig. 1). The coldest temperature recorded was 11°F in December 2022 (Fig. 2). Monthly lowest temperatures were higher on average in the fall (September to December) of 2021 while monthly lowest temperatures were higher in the spring (January to May) of 2023. Abnormally high rainfall in September combined with higher lower temperatures in the fall of 2021 resulted in greater plant growth and development in the 2021-2022 season.

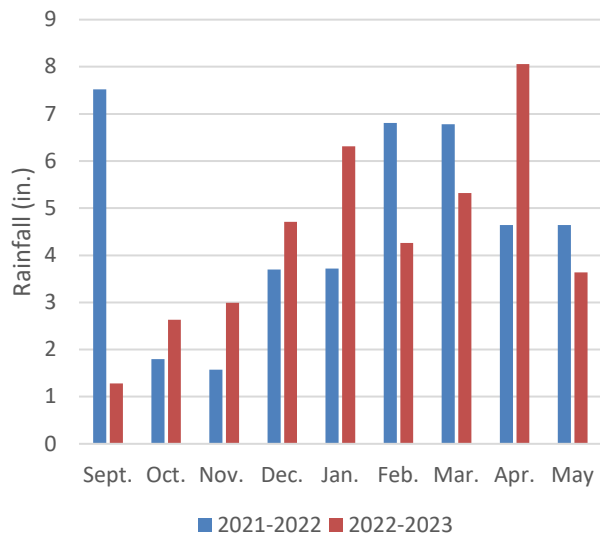


Figure 1. Monthly rainfall from September – May for the 2021-2022 and 2022-2023 seasons. USDA-NRCS, Coffeerville, MS, 2024.

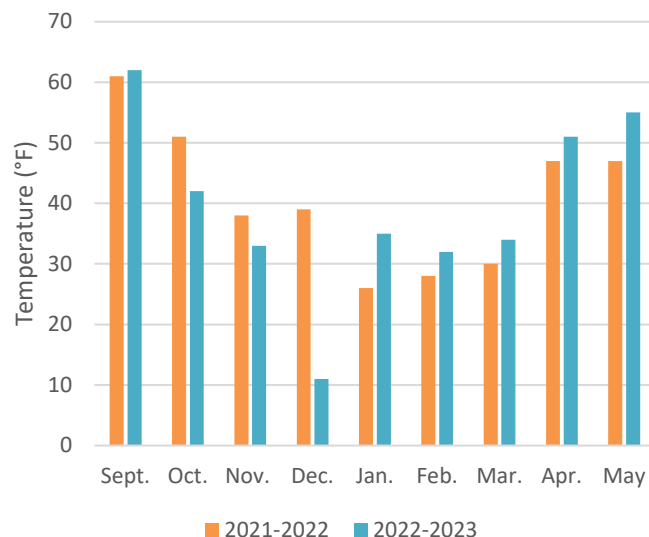


Figure 2. Monthly lowest temperature from September – May for the 2021-2022 2022-2023 seasons. USDA-NRCS, Coffeerville, MS, 2024.

Growing Degree Day (GDD) accumulation for the 2021-2022 and 2022-2023 growing seasons.

All planting dates were significantly different for GDD-40 accumulation (Fig. 3) Earlier planting dates accumulated more GDD-40 compared to later planting dates when averaged across harvest dates. The highest GDD-40 accumulation was achieved with a September 15 (3058) planting followed by October 1 (2536), October 15 (2158), November 1 (1779), and November 15 (1595) planting (Fig. 3). The September 15 planting date accumulated 1463 more GDD-40 units compared to a November 15 planting.

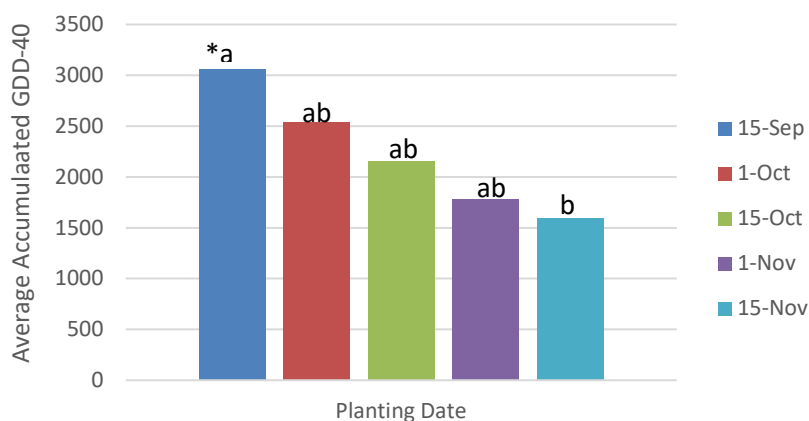


Figure 3. Planting date comparison of GDD-40 accumulation for the 2021-2022 and 2022-2023 seasons. USDA-NRCS, Coffeerville, MS, 2024. *Bars followed by different letters are significantly different according to Tukey's HSD all pairwise comparison at $P < 0.05$.

There were significant differences in average GDD-40 accumulation among harvest dates (Fig. 4). Later harvest dates accumulated more GDD-40 units compared to earlier harvest dates. The highest GDD-40 accumulation was a May 1 (2798) harvest followed by April 1 (2154) and March 1 (1723) harvest. On average, May 1 harvest dates had 1075 more GDD-40 units compared to March 1.

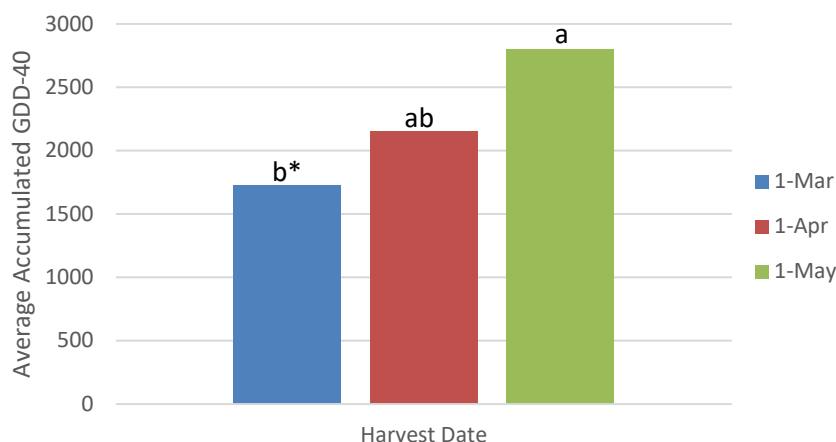


Figure 4. Harvest date comparison of GDD-40 accumulation for the 2021-2022 and 2022-2023 seasons. USDA-NRCS, Coffeerville, MS, 2024. *Bars followed by different letters are significantly different according to Tukey's HSD all pairwise comparison at $P < 0.05$.

Black-Seeded Oat (BSO)

Growth stage development at harvest was more advanced for BSO planted between September 15 to October 15 compared to November planted treatments (Table 2). Cooler fall temperatures (Fig. 2) and higher rainfall in November (Fig. 1) delayed maturity of BSO. Additionally, GDD-40 accumulation was decreased in November due to fewer growing days prior to first frost (mid to late November in North Mississippi) resulting in less developed plants in the early spring. It is recommended that BSO is planted between September 15 and October 15 to maximize plant development and forage quantity.

Table 2. Effect of planting date and harvest date on growth stage of black-seeded oats in 2021-2022 and 2022-2023. USDA-NRCS, Coffeerville, MS.

Planting Date	Harvest Date		
	March 1	April 1	May 1
September 15	Advanced Tillering	Booting	Heading
October 1	Advanced Tillering	Booting	Heading
October 15	Advanced Tillering	Booting	Heading
November 1	Early Tillering	Advanced Tillering	Booting
November 15	Early Tillering	Advanced Tillering	Booting

Dry matter yields (DMY) were higher for earlier planting dates and/or later harvest dates. For instance, the highest DMY was achieved with an October 15 planting date and a May 1 harvest date (6917 lb/acre) (Table 3). Earlier planting dates can take advantage of greater GDD-40 accumulation prior to winter quiescence compared to later plantings (Fig. 3). Black-seeded oat harvested on March 1 accumulated significantly more DMY when planted between September 15 to October 15 compared to the November 15 planting (Table 3). Conversely, later planting dates could accumulate GDD-40's by delaying harvest in the spring (Fig. 4). There was no significant difference amongst DMY regardless of planting date when harvested May 1 (Table 3). The lowest DMY was achieved with a November 15 planting and a March 1 harvest (526 lb/acre). To maximize DMY and promote earlier harvest, it is recommended to plant BSO between September 15 and October 15.

Percent crude protein (CP) declined with increased maturity. The highest CP was achieved with a November 1 planting and a March 1 harvest (20%) which corresponds with early tillering growth stage (Table 2). However, the lowest CP was achieved with a September 15 planting and a May 1 harvest (8%) which corresponds to the heading stage. Later plantings (November 1 to November 15) had delayed maturity which in combination with earlier harvest resulted in higher forage quality. All treatments produced sufficient CP for maintaining dry

pregnant beef cattle (7-8% CP), but lactating beef cows (10-12% CP) would require protein supplementation when grazing BSO planted between September 15 and November 1 when grazing on or after April 1 (Ball et al, 1991).

Total digestible nutrients (TDN) declined with increased maturity (Table 3). The highest TDN was achieved with a November 1 planting and a March 1 harvest (69%), and the lowest TDN with an October 15 planting and May 1 harvest (55%). In general, TDN increased between March 1 and April 1 across all planting dates; however, TDN decreased from April 1 to May 1. The one exception to this trend was observed with a November 1 planting which experienced a significant decrease in TDN as harvest was delayed. At the March 1 harvest, the November 1 planting (69%) had a greater TDN compared to September 15 (56%) and October 1 plantings (57%). Black-seeded oats planted between September 15 and October 1 were in the advanced tillering stage on a March 1 harvest while the November plantings were in the early tillering stage which had more digestible energy (Table 2). This same trend was observed in the April 1 harvest in which BSO planted between November 1 (62%) and November 15 (67%) had greater TDN compared to September 15 (58%) and October 1 (58%). Black-seeded oats planted in November were in the advanced tillering stage April 1 while September 15 to October 15 plantings were in the booting stage. This indicates that forage digestible energy decreased as forage maturity increases. During the May 1 harvest there was no significant difference in planting dates for TDN (Table 3). All treatments produced adequate TDN required for dry pregnant beef cattle ($\geq 50\%$) (Ball et al, 1991). However, BSO planted September 15 to October 15 would have required supplementation regardless of termination date to meet the needs of an early-stage lactating cow ($\geq 60\%$). November planted BSO met the needs of an early-stage lactating cow until April 1; afterwards, energy supplementation would be needed to meet nutritional requirements of lactating cows.

Table 3. Effect of planting and harvest date on dry matter yield (DMY), crude protein (%CP), total digestible nutrients (%TDN) on black-seeded oats in 2021-2022 and 2022-2023. USDA-NRCS, Coffeerville, MS.

Planting Date	Harvest Date								
	DMY (lbs/acre)			%CP			%TDN		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	3206 aA*	3557 aA	5281 aA	11 aB	9 aB	8 aB	56 aB	58 aC	56 aA
October 1	3134 aA	4418 aA	4507 aA	11 aB	9 aB	8 aB	57 aB	58 aC	56 aA
October 15	2835 bA	3519 aA	6917 aA	12 aB	10 abB	8 bAB	59 aAB	60 aBC	55 bA
November 1	929 cAB	3355 bA	5839 aA	20 aA	12 bB	9 bAB	69 aA	62 bB	56 cA
November 15	526 bB	1079 bB	5222 aA	18 aAB	16 abA	11 bA	66 aAB	67 aA	58 aA

*Means within row for a planting date followed by the same lower-case letters and within columns for a harvest date followed by the same upper-case letters are not significantly different at $P < 0.05$ according to Tukey's HSD all pairwise comparisons test.

There was no significant difference in acid detergent fiber (ADF) regardless of planting and harvest date combinations except for the November 1 planting date (Table 4). Black-seeded oats planted November 1 and harvested March 1 (20%) had significantly lower ADF compared to November 1 planting that was harvested May 1 (28%). The highest ADF was achieved with a September 15 planting and March 1 harvest (32%) while the lowest ADF was achieved with a November 1 planting and April 1 harvest (20%). The range of ADF for BSO (20-32%) were below the expected values for small grains (35-46%) according to Ball et al. (2002). A lower ADF reported for BSO in this study indicates a higher digestibility than typical small grain forages.

Neutral detergent fiber (NDF) was not significantly different across planting and harvest date combinations when planted between September 15 to October 15 (Table 4). However, NDF did increase significantly when BSO was planted in November and harvest was delayed until May 1. For instance, BSO planted on November 1 and harvested April 1 to March 1 (39-42%) had significantly lower NDF compared to BSO planted November 1 and harvested May 1 (54%). A similar trend for NDF was observed when BSO was planted November 15 and harvested April 1 (38%) and May 1 (54%). These increased in NDF would result in lower forage quality due to the corresponding increase in BSO maturity. As a result, it would be recommended to graze BSO earlier to obtain lower NDF.

Relative forage quality (RFQ) ranged from 172 to 102 with the highest RFQ achieved when BSO was planted November 15 and harvested April 1 (Table 4). The lowest RFQ occurred because of a September 15

planting and March 1 harvest (102). There was no significant difference between planting dates within the same harvest date. However, BSO planted on October 15, November 1, and November 15 had greater RFQ when harvested March 1 (130, 161, and 154) and April 1 (151, 156, and 172) compared to May 1 (103, 102, and 106). This trend corresponds the physiological growth stage of BSO (tiller>booting>heading) resulting in higher NDF (Table 4) and lower TDN (Table 3). Except for the September 15 (102) planting, RFQ of the March 1 harvest were categorized as good for October 1 (115) and October 15 (130) plantings with November 1 (161) and November 15 (154) categorized as premium (Appendixes 1). Regardless of planting date, the RFQ of BSO harvested April 1 would be rated as good with October 1 (143), October 15 (151), November 1 (156), and November 15 (172) as premium. However, all treatments except for BSO planted on October 1 (118) had RFQ categorized as fair when harvested May 1 (Appendixes 1). All planting and harvest dates were sufficient to meet the RFQ for dry pregnant beef cattle (Appendixes 2). Black-seeded oats planted between October 15 and November 15 had RFQ values when harvested between March 1 and April 1 for lactating beef cows (115-130) and stocker cattle (125-140). However, October 1 planting produced sufficient RFQ values to sustain a lactating beef cow regardless of harvest date. It is recommended BSO is planted between October 1 and November 15 to maximize RFQ.

Table 4. Effect of planting and harvest date on acid detergent fiber (%ADF), neutral detergent fiber (%NDF), and relative forage quality (RFQ) of black-seeded oats in 2021-2022 and 2022-2023. USDA-NRCS, Coffeerville, MS

Planting Date	Harvest Date								
	%ADF			%NDF			RFQ		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	32 aA*	25 aA	28 aA	55 aA	49 aA	51 aA	102 aA	129 aA	108 aA
October 1	30 aA	22 aA	24 aA	51 aA	41 aA	47 aA	115 aA	143 aA	118 aA
October 15	25 aA	20 aA	27 aA	46 aA	40 aA	53 aA	130 abA	151 aA	103 bA
November 1	24 abA	20 bA	28 aA	42 bA	39 bA	54 aA	161 aA	156 aA	102 bA
November 15	26 aA	25 aA	28 aA	43 abA	38 bA	54 aA	154 aA	172 aA	106 bA

*Means within row for a planting date followed by the same lower-case letters and within columns for a harvest date followed by the same upper-case letters are not significantly different at $P<0.05$ according to Tukey's HSD all pairwise comparisons test.

Cereal Rye (CR)

Cereal rye maturity was delayed when planted in November of both seasons. Lower temperatures (Fig. 2) and higher rainfall (Fig. 1), related to a later planting, resulted in fewer GDD-40s accumulation in the fall when planted in November (Fig. 3). Rainfall in September 2021 was 6.24 inches greater than September 2022 (Fig. 1). Above freezing temperatures between September to December 2021 (Fig. 2) resulted in greater GDD-40 accumulation leading to advanced plant development in the 2022-2023 season. Despite these seasonal differences, CR was in the tillering and dough stage of development March 1 and May 1, respectively (Table 5).

Table 5. Effect of planting date and harvest date on growth stage of cereal rye in 2021-2022 and 2022-2023. USDA-NRCS, Coffeerville, MS.

Planting Date	Harvest Date (2022)		
	March 1	April 1	May 1
September 15	Advanced Tillering	Anthesis	Hard Dough
October 1	Advanced Tillering	Anthesis	Hard Dough
October 15	Advanced Tillering	Anthesis	Hard Dough
November 1	Advanced Tillering	Heading	Soft Dough
November 15	Advanced Tillering	Bootling	Anthesis
Planting Date	Harvest Date (2023)		
	March 1	April 1	May 1
September 15	Advanced Tillering	Heading	Soft Dough
October 1	Advanced Tillering	Heading	Soft Dough
October 15	Advanced Tillering	Heading	Soft Dough
November 1	Early Tillering	Bootling	Soft Dough
November 15	Early Tillering	Bootling	Soft Dough

Dry matter yield was higher in 2021-2022 compared to 2022-2023 (Table 6) due to higher rainfall in September 2021 and higher fall/winter temperatures that resulted in greater plant growth (Figs. 1 and 2). Earlier planting and/or later harvest dates produced greater DMY in the spring. The highest DMY was achieved with a November 1 planting and May 1 harvest (8372 lb/acre) in 2021-2022, and an October 15 planting and May 1 harvest (4275 lb/acre) in 2022-2023. Earlier planting dates allowed for greater GDD-40's accumulation prior to winter quiescence as opposed to later plantings (Fig. 3). However, later planting dates accumulate most of their GDD-40's by delaying harvest in the spring (Fig. 4). The lowest DMY were achieved by a combination of a later planting date and early harvest date. For instance, the lowest DMY was achieved by a combination of a November 15 planting and March 1 termination in 2021-2022 (1006 lb/acre) and 2022-2023 (246 lb/acre). Later planting dates accumulated fewer GDD-40's in the fall and earlier harvesting accumulated less GDD-40's in the spring resulting in limited plant growth. In both seasons, there was not a significant difference in dry matter production on May 1 regardless of planting date.

Percent crude protein declined with increased maturity (Table 6). The highest CP was achieved with a November 15 planting and a March 1 harvest in 2021-2022 (19%) and 2022-2023 (21%). However, an October 1 planting and May 1 harvest produced the lowest CP in both 2021-2022 (6%) and 2022-2023 (6%) which is anticipated because of the later stage of maturity of the CR (hard dough and soft dough growth stages). Later plantings (November 1 to November 15) produced smaller plants with higher N content due to earlier harvest and less GDD-40's resulting in plants with higher CP (Fig. 3 and Fig. 4). All planting dates harvested from March 1 to April 1 produced sufficient CP for maintaining dry pregnant beef cattle (7-8% CP) and lactating cows (10-12%) (Ball et al., 1991). However, harvesting between April 1 to May 1 would require additional protein supplementation for dry pregnant cows when planted between September 15 and November 1 in both seasons. Percent crude protein was sufficient for maintaining dry pregnant cows when planted November 15 regardless of harvest date in both seasons. However, November 15 planting date produced sufficient CP for sustaining a lactating cow on May 1 in 2022-2022, but CP was insufficient for lactating cows on May 1 2021-2022. To maintain dry pregnant and lactating cows when grazing, provide supplemental protein after April 1 if planted between September 15 to November 1. Planting CR on or after November 15 is not recommended because planting too late in the fall will result in lower DMY in the spring (Table 6).

Total digestible nutrients (TDN) declined with earlier planting and delayed harvest dates (Table 6). The lowest TDN was achieved with an October 1 planting and a May 1 harvest in both 2021-2022 (48%) and 2022-2023 (48%). Cereal rye harvested May 1 was in the dough stages (soft or hard dough) regardless of planting date in both seasons that contributed to lower TDN. These findings are like those reported by Landry et al. (2019) who observed a decrease in TDN from the boot stage to seed head emergence. The highest TDN was reached with a November 15 planting and a March 1 harvest in both 2021-2022 (73%) and 2022-2023 (70%). Cereal rye planted November 15 was in the vegetative growth stage when terminated March 1 of both years resulting in significantly higher TDN when grazed or terminated during the tillering stage. Kantar et al (2011) reported CR produced more dry matter yield when harvested at the dough stage, but CP was greater when harvested at tillering. As a result of these findings, graze CR between March 1 and April 1 to maintain sufficient TDN for dry pregnant cattle ($\geq 50\%$) and lactating cattle (≥ 60) with supplementation (Ball et al., 1991). However, for bedding material, hay CR between April 1 and May 1 when fiber content is higher.

Table 6. Effect of planting and harvest date on dry matter yield (DMY), crude protein (%CP), total digestible nutrients (%TDN) on cereal rye in 2021-2022 and 2022-2023. USDA-NRCS, Coffeetown, MS.

Planting Date	Harvest Date (2022)								
	DMY (lbs/acre)			%CP			%TDN		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	2781 aA*	5202 aA	7163 aA	12 aA	11 aA	6 bAB	62 aB	59 aAB	49 bA
October 1	3241 aA	3808 aA	7363 aA	13 aA	9 aA	6 aB	62 aB	56 abB	48 bA
October 15	3480 bA	5385 bA	7769 aA	14 aA	11 aA	6 aAB	64 aAB	58 abAB	48 bA
November 1	2279 bA	3833 bA	8372 aA	17 aA	14 abA	6 bAB	70 aAB	63 aAB	48 bA
November 15	1006 bA	2247 abA	6572 aA	19 aA	15 abA	8 bA	73 aA*	66 aA	50 bA
Planting Date	Harvest Date (2023)								
	DMY (lbs/acre)			%CP			%TDN		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	1733 aA	4043 aA	3762 aA	11 aA	10 abC	6 bB	57 aA	55 aC	48 bB
October 1	2200 aA	3284 aAB	3477 aA	10 aA	9 aC	6 aB	56 aA	55 aC	48 bB
October 15	1962 cA	2500 bBC	4275 aA	10 aA	10 C	7 B	56 aA	57 aC	48 aB
November 1	842 bAB	1872 abC	3790 aA	17 aA	13 aB	7 aB	65 aA	62 aB	48 aB
November 15	246 aB	770 aD	1069 aA	21 aA	16 aA	12 aA	70 aA*	66 aA	56 bA

Means within row for a planting date followed by the same lower-case letters and within columns for a harvest date followed by the same upper-case letters are not significantly different at $P < 0.05$ according to Tukey's HSD all pairwise comparisons test.

Acid detergent fiber (ADF) was significantly greater with earlier planting and delayed harvest (Table 7). Cereal rye planted November 15 and terminated March 1, 2022 (14%) and April 1, 2023 (22%) had the lowest ADF values in their respective seasons. In both seasons, the highest ADF was highest November 1 planting and a May 1 harvest resulting in 40% and 42% in 2021-2022 and 2022-2023, respectively (Table 7). Within the same planting date, CR had significantly higher ADF when harvest was delayed until May 1 compared to March 1 and April 1 harvests in both seasons. During the 2021-2022 season, CR planted November 1 and November 15 had significantly lower ADF when harvested March 1 and April 1 compared to other planting dates. Cereal rye harvested May 1, 2022, had similar ADF regardless of planting date. In the 2022-2023 season, CR had similar ADF values amongst planting dates when harvest took place on March 1. Acid detergent fiber was significantly lower when planted November 1 (24%) and November 15 (22%) and harvested April 1, 2023. Also, CR planted on November 15 (38%) had significantly lower ADF when harvested May 1, 2023, compared to the November 1 planting (42%). November planted treatments maintained the lowest ADF between March 1 and April 1 compared to earlier plantings. To maximize forage quality, plant CR between November 1 and November 15 and graze or harvest from March 1 to April 1.

Neutral detergent fiber (NDF) was significantly increased when planted between September 15 and October 15 and/or harvest was delayed until May 1 (Table 7). For instance, the highest NDF were produced with an October 15 (73%) and November 1 (76%) planting with a May 1 harvest in both 2021-2022 and 2022-2023, respectively. These planting and harvest date combinations correspond to the dough growth stage in both seasons (Table 5). On the other hand, planting November 15 and harvesting March 1 lowered NDF in 2021-2022 (32%) and 2022-2023 (41%). This planting and harvest date combination corresponds to the early and advanced tillering growth stage for the 2021-2022 and 2022-2023 growing season respectively (Table 5), when fiber content is lower in the plants (Table 7). To decrease NDF and improve TDN and intake, plant CR between November 1 and November 15 and harvest from March 1 to April 1.

Relative forage quality (RFQ) ranged from 221 to 65 in 2021-2022 and 165 to 62 in 2022-2023 with the highest RFQ being achieved with a November 15 planting and a March 1 harvest in both seasons (Table 7). The lowest RFQ was achieved with a November 1 planting and a May 1 harvest in 2021-2022 (65) and 2022-2023 (62). Cereal rye planted on November 1 and November 15 had premium quality forage when harvested on March 1 and good quality forage when harvested on April 1 regardless of the season (Appendixes 1). When planted between September 15 and October 15, CR had good and fair RFQ values when harvested March 1 in 2021-2022 and 2022-2023, respectively. However, RFQ values dropped to fair and utility forage quality categories (Appendixes 1) when planted between September 15 to October 15 and harvested April 1 in both seasons. Regardless of planting date and season, RFQ values were categorized as utility when harvested May 1. To maximize RFQ, graze or harvest between March 1 and April 1 if planted between November 1 and November 15. The quality of the CR forage will

likely meet the RFQ needs for both dry cows (100-115) and lactating beef cattle (115-130) (Appendixes 2). It is not recommended to graze CR after April 1 due to the low RFQ regardless of planting date.

Table 7. Effect of planting and harvest date on acid detergent fiber (%ADF), neutral detergent fiber (%NDF), and relative forage quality (RFQ) of cereal rye in 2021-2022 and 2022-2023. USDA-NRCS, Coffeetown, MS.

Planting Date	Harvest Date (2022)								
	%ADF			%NDF			RFQ		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	22 cAB*	27 bABC	39 aA	46 cA	58 bAB	72 aA	131 aB	98 bB	67 cA
October 1	26 bA	30 abA	40 aA	50 cA	62 bA	72 aA	121 aB	88 bB	65 cA
October 15	22 bAB	27 bAB	39 aA	46 bAB	59 abA	73 aA	138 aB	96 bB	65 cA
November 1	15 bB	24 bBC	40 aA	34 cBC	53 bBC	72 aA	200 aA	117 bAB	65 cA
November 15	14 cB	21 bC	40 aA	32 cC	48 bC	71 aA	221 aA	135 bA	69 cA
Planting Date	Harvest Date (2023)								
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	30 bA	32 bA	41 aAB	53 cAB	62 bA	72 aA	105 aAB	86 bD	65 cB
October 1	32 bA	31 bAB	41 aAB	56 cA	61 bA	72 aA	97 aB	89 aCD	64 bB
October 15	30 bA	28 bB	40 aAB	51 bABC	56 bB	72 aA	109 aAB	100 abC	65 bB
November 1	25 bA	24 bC	42 aA	43 bBC	50 bC	76 aA	148 aAB	120 abB	62 bB
November 15	24 bA	22 bC	38 aB	41 bC	44 bD	68 aB	165 aA*	148 aA	80 bA

*Means within row for a planting date followed by the same lower-case letters and within columns for a harvest date followed by the same upper-case letters are not significantly different at $P < 0.05$ according to Tukey's HSD all pairwise comparisons test.

Winter Triticale (TRI)

Winter triticale matured earlier in the 2021-2022 compared to the 2022-2023. It is likely due to higher rainfall in September of 2021 (Fig. 1) and the availability of soil moisture for the first three planting dates (September 15 to October 15). Additionally, above freezing temperatures between September and December 2021 (Fig. 2) resulted in greater GDD-40 accumulation; thereby, increasing plant development in the fall of 2021-2022. All planting dates on March 1 and April 1 were in the tillering growth stage. When harvested May 1, TRI maturity ranged from dough stage to heading in 2021-2022 and from heading to boot in 2022-2023 (Table 8). As a result, initiate grazing or harvest between March 1 and April 1 to avoid feeding heavy supplementation.

Table 8. Effect of planting date and harvest date on growth stage of winter triticale in 2021-2022 and 2022-2023. USDA-NRCS, Coffeetown, MS.

Planting Date	Harvest Date (2022)		
	March 1	April 1	May 1
September 15	Advanced Tillering	Advanced Tillering	Soft Dough
October 1	Advanced Tillering	Advanced Tillering	Anthesis
October 15	Advanced Tillering	Advanced Tillering	Heading
November 1	Advanced Tillering	Advanced Tillering	Heading
November 15	Advanced Tillering	Advanced Tillering	Heading
Planting Date	Harvest Date (2023)		
	March 1	April 1	May 1
September 15	Advanced Tillering	Advanced Tillering	Heading
October 1	Advanced Tillering	Advanced Tillering	Heading
October 15	Advanced Tillering	Advanced Tillering	Heading
November 1	Early Tillering	Advanced Tillering	Boot
November 15	Early Tillering	Early Tillering	Boot

Dry matter yield was higher in 2021-2022 compared to 2022-2023 (Table 9) due to higher rainfall in September 2021 and higher fall/winter temperatures that resulted in greater plant growth (Fig. 1 and 2). Earlier planting and/or later harvest dates resulted in greater DMY. For instance, the highest DMY was obtained with a November 1 planting and May 1 harvest (9344 lb/acre) in 2021-2022 and an October 15 planting and May 1 harvest (3819 lb/acre) in 2022-2023 (Table 11). Earlier planting dates allows for greater GDD-40 accumulation

prior to winter quiescence compared to later plantings. However, later planting dates only accumulate GDD-40s by delaying harvest in the spring. Lower DMY are expected with later planting dates and early harvest dates. For example, the lowest DMY was achieved by a combination of a November 15 planting and March 1 harvest in 2021-2022 (820 lb/acre) and 2022-2023 (196 lb/acre) (Table 11). Later planting dates accumulated fewer GDD-40 in the fall and earlier harvest accumulated less GDD-40s in the spring resulting in limited plant growth. In both seasons, there was not significant difference in dry matter production on May 1 regardless of planting date (Table 9).

In general, CP was higher in 2021-2022 compared to 2022-2023 (Table 9) due to higher fall/winter temperatures and rainfall in September 2021 (Fig. 1 and 2). The highest CP was achieved with a November 15 planting and a March 1 harvest in 2021-2022 (23%) and 2022-2023 (24%). As expected, CP declined with delayed harvest. For example, CP was lowest with a November 1 planting and May 1 harvest (8%) in 2021-2022 and an October 15 planting and May 1 harvest (8%) in 2022-2023. All planting and harvest date combinations provided sufficient CP to meet the protein needs of dry (non-lactating) beef cattle (Ball et al., 1991). However, lactating cattle (10-12% CP) could only be maintained when TRI was planted between October 15 and November 15 and grazed on or before April 1 in both seasons (Ball et al., 1991). To maintain adequate levels of CP, lactating cows would need supplemental protein when grazing TRI after April 1.

Total digestible nutrient (TDN) decreased as harvest was delayed (Table 9). The highest TDN was achieved with a November 15 planting and a March 1 harvest in 2021-2022 (76%) and 2022-2023 (74%). Conversely, the lowest TDN occurred with a May 1 termination when combined with a November 1, 2021 (52%) and October 15, 2022 (51%) planting. During the 2021-2022 season, TDN decreased significantly within planting date when harvest was delayed until May 1 for TRI planted between October 15 to November 15. However, during the 2022-2023, TRI experienced a significant decrease in TDN within planting date when planted between November 1 and November 15 and harvest was delayed until April 1 and May 1. Total digestible nutrients were within the acceptable range for dry cattle regardless of planting or harvest date. To meet the TDN requirements for lactating cattle, plant TRI from October 15 to November 15 and graze/harvest between March 1 and April 1 (Ball et al., 1991). Any other planting and harvest date combination for TRI to meet the TDN requirements of a lactating cow would require additional supplementation.

Table 9. Effect of planting and harvest date on dry matter yield (DMY), crude protein (%CP), total digestible nutrients (%TDN) on winter triticale in 2021-2022 and 2022-2023. USDA-NRCS, Coffeerville, MS.

Planting Date	Harvest Date (2022)								
	DMY (lbs/acre)			%CP			%TDN		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	3569 aAB*	4988 aA	8575 aA	15 aB	12 aB	9 aA	65 aB	57 aC	53 aA
October 1	4892 aA	4489 aA	4329 aA	14 aB	11 abB	10 bA	60 aB	54 aBC	54 aA
October 15	4215 bA	5406 abA	6501 aA	16 aB	12 abAB	9 bA	66 aB	59 abABC	53 bA
November 1	1826 bAB	3922 bA	9344 aA	22 aA	16 aA	8 bA	75 aA	65 aA	51 bA
November 15	820 bB	2457 bA	7374 aA	23 aA*	15 bAB	9 bA	76 aA	64 bAB	53 cA
Planting Date	Harvest Date (2023)								
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	1230 bA	2125 aA	2339 aA	13 aB	9 aA	8 aB	59 aB	56 aA	52 aA
October 1	1138 aA	1954 aAB	1947 aA	12 aB	9 aA	8 aB	58 aB	55 abA	51 bA
October 15	1141 aA	1983 aAB	3819 aA*	14 aB	12 aA	8 aB	62 aB	62 aA	51 aA
November 1	474 bAB	849 bAB	2813 aA	22 aA	13 bA	10 bAB	72 aA	62 bA	55 cA
November 15	196 aB	524 aB	870 aA	24 aA*	13 abA	12 bA	74 aA*	62 bA	59 cA

*Means within row for a planting date followed by the same lower-case letters and within columns for a harvest date followed by the same upper-case letters are not significantly different at $P < 0.05$ according to Tukey's HSD all pairwise comparisons test.

Acid detergent fiber (ADF) increased with earlier planting and/or delayed harvest dates (Table 10). For instance, TRI planted November 15, 2021 (14.3%) and November 1, 2022 (22.5%) produced the lowest ADF when harvested on March 1. Conversely, the highest ADF was achieved with a May 1 harvest date and a November 1, 2021 (38%) and October 1, 2022 (36%) planting. In general, ADF values within the same planting date were lowest and highest when harvested on March 1 and May 1, respectively. Winter triticale experienced an increase in

maturity when harvest was delayed from April 1 (Tillering) to May 1 (boot to soft dough) resulting in an increase in fiber content and subsequently higher ADF. A similar trend was reported by Keles et al (2017) who observed that winter triticale had higher nutritive value (lower ADF) when in the tillering and stem elongation growth stages. To maximize nutritive value, it is recommended that TRI s be either grazed or harvested prior to May 1 to maintain a low ADF and high TDN.

Winter triticale experienced a significant increase in neutral detergent fiber (NDF) when harvest was delayed until May 1 within the same planting date. For example, the highest NDF were achieved with a May 1 harvest in combination with a November 1, 2021 (69%) and October 1, 2022 (71%) planting date (Table 10). These planting and harvest date combinations correspond to TRI seed heading emergence which caused a decline in nutritive value (Table 8). The lowest NDF occurred in the tillering stage at the November 15 planting and a March 1 harvest in 2021-2022 (34%) and 2022-2023 (42%). This is supported by Keles et al (2017) who reported that winter triticale had higher nutritive value (lower NDF) at the tillering and stem elongation growth stages. As a result, it is recommended that TRI be grazed or harvested between March 1 and April 1 to maintain a lower NDF and improve animal intake.

Relative forage quality (RFQ) decreased with early planting and/or later harvest dates, resulting in increased maturity (Table 10). For instance, RFQ ranged from 219 to 74 in 2021-2022 and 171 to 71 in 2022-2023. The highest RFQ was achieved with a November 15 planting and a March 1 harvest in both seasons. Winter triticale planted November 15 and harvested on March 1 was in the advanced tillering stage in 2021-2022 and early tillering stage in 2022-2023 producing a higher nutritive value (Table 8). The lowest RFQ was achieved with a November 1 planting and May 1 harvest (74) in 2021-2022, and an October 15 planting and May 1 harvest (71) in 2022-2023 which correspond to the heading stage. Winter triticale planted between November 1 and November 15 had premium to good RFQ when harvested March 1 and April 1 in 2021-2022 and 2022-2023 (Appendixes 1). Except for the October 1 planting and April 1 harvest, TRI planted between September 15 and October 15 maintained premium to fair RFQ when harvested between March 1 and April 1. Regardless of planting date and/or season, TRI harvested May 1 had utility RFQ indicating a significant decrease in RFQ (Appendixes 1). As a result, the RFQ would not provide the feed quality for dry cows (Appendixes 2) when harvested on May 1 regardless of planting date without sufficient supplementation. To provide sufficient RFQ for lactating cows, plant TRI between November 1 and November 15 to obtain a grazing and harvest period from March 1 to April 1 (Appendixes 2).

Table 10. Effect of planting date and harvest date on acid detergent fiber (%ADF), neutral detergent fiber (%NDF), and relative forage quality (RFQ) of winter triticale in 2021-2022 and 2022-2023. USDA-NRCS, Coffeeville, MS

Planting Date	Harvest Date (2022)								
	%ADF			%NDF			RFQ		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	22 aB	31 aAB	35 aA	45 bAB	59 abA	64 aA	140 aC	95 aB	81 aA
October 1	31 aA	37 aA	35 aA	54 bA	62 abA	67 aA	108 aC	85 aB	79 aA
October 15	20 bB	29 abB	36 aA	42 bBC	57 abA	68 aA	155 aBC	101 abB	76 bA
November 1	16 cB	24 bB	38 aA	35 cC	50 bB	69 aA	208 aAB	127 bA	74 bA
November 15	14 cB	24 bB	36 aA	34 cC-	49 bB	66 aA	219 aA*	129 bA	79 bA
Planting Date	Harvest Date (2023)								
	%ADF			%NDF			RFQ		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	31 abA	28 bA	36 aAB	55 bA	50 cA	70 aA	105 aB	109 aA	72 bB
October 1	31 bA	29 bA	36 aA	54 bA	52 bA	71 aA	106 aB	104 aA	71 bB
October 15	26 aB	23 aA	36 aAB	46 aB	44 aA	70 aA	132 aB	139 aA	71 aB
November 1	23 bB	23 bA	32 aBC	43 bBC	44 bA	65 aB	165 aA	139 bA	83 cBA
November 15	23 aB	23 aA	29 aC	42 aC-	43 aA	59 aC	171 aA*	143 bA	97 cA

*Means within row for a planting date followed by the same lower-case letters and within columns for a harvest date followed by the same upper-case letters are not significantly different at $P < 0.05$ according to Tukey's HSD all pairwise comparisons test.

Winter Wheat (WW)

Winter wheat (WW) matured earlier in the 2021-2022 season compared to the 2022-2023 season (Table 11. It is likely higher rainfall in the fall of 2021 (Fig. 1) combined with the above freezing temperatures (Fig. 2) resulted in greater available soil moisture and GDD-40 accumulation and plant development (Fig. 3). All planting dates were in the tillering growth stage March 1 in 2021-2022 and 2022-2023. Only WW planted November 1 and November 15 maintained tillering growth stage to April 1 of both seasons with earlier plantings reaching the boot stage in 2021-2022. Regardless of planting date, WW reached anthesis or dough stage May 1.

Table 11. Effect of planting date and termination date on growth stage of winter wheat in 2021-2022 and 2022-2023. USDA-NRCS, Coffeeville, MS.

Planting Date	Harvest Date (2022)		
	March 1	April 1	May 1
September 15	Advanced Tillering	Booting	Soft Dough
October 1	Advanced Tillering	Booting	Soft Dough
October 15	Advanced Tillering	Booting	Soft Dough
November 1	Advanced Tillering	Advanced Tillering	Soft Dough
November 15	Advanced Tillering	Advanced Tillering	Anthesis
Planting Date	Harvest Date (2023)		
	March 1	April 1	May 1
September 15	Advanced Tillering	Advanced Tillering	Soft Dough
October 1	Advanced Tillering	Advanced Tillering	Soft Dough
October 15	Advanced Tillering	Advanced Tillering	Soft Dough
November 1	Early Tillering	Advanced Tillering	Soft Dough
November 15	Early Tillering	Advanced Tillering	Anthesis

Dry matter yield of was higher in 2021-2022 than 2022-2023 (Table 12). Higher rainfall and warmer fall/winter temperatures influenced yields (Figs. 1 and 2). As expected, delaying planting and/or earlier harvest dates produced lower DMY. Lower DMY occurred when WW was planted November 15 and harvested March 1 in 2021-2022 (767 lb/acre) and 2022-2023 (321 lb/acre). Later planting dates had to largely depend on accumulation of GDD-40s during the spring as opposed to fewer growing conditions in fall prior to winter quiescence. Earlier planting dates accumulated more GDD-40s in the fall prior to winter quiescence. The highest DMY was achieved with a September 15 planting combined with a May 1 (7887 lb/acre) and April 1 (4903 lb/acre) harvest date in 2021-2022 and 2022-2023, respectively (Table 12). In both seasons, WW harvested May 1 did not produce as much DMY when planted between September 15 to October 15. These results suggest WW should be planted between September 15 to October 15 to maximize yield.

Winter wheat had higher crude protein (CP) in 2021-2022 than 2022-2023 (Table 12). Favorable soil moisture and temperatures in the fall of 2021 (Fig. 1 and 2) likely affected CP. Crude protein ranged from 20% to 9% in 2021-2022 and 17% to 8% in 2022-2023 (Table 12). Earlier planting and/or earlier harvest dates generally produced higher CP while allowing the WW to grow into the late spring produced less CP. For instance, the highest and lowest CP was achieved with a November 1 planting combined with a March 1 harvest and a September 15 planting combined with a May 1 harvest in both seasons, respectively. All planting and termination date combinations had sufficient levels of CP (7-8%) to maintain dry cows according to Ball et al. (1991). Only WW planted between October 15 and November 15 had sufficient levels of CP (10-12%) to maintain lactating cows (Ball et al., 1991) regardless of harvest date and/or season (Table 12). To maintain CP, it is recommended that WW be planted between October 15 and November 15 to prolong CP levels from March 1 to May 1 extend the grazing or harvest window.

Total digestible nutrients (TDN) were slightly higher in 2021-2022 compared to 2022-2023 (Table 12). Plant growth was affected by rainfall (Fig. 1) and temperature conditions (Fig. 2) in the fall of 2021. Total digestible nutrients ranged from 73% to 55% in 2021-2022 and from 66% to 53% in 2022-2023. Earlier planting and/or harvest dates produced higher TDN when plants were in the early stages of plant growth and development. For instance, the highest and lowest TDN were achieved with a November 1 planting combined with a March 1 harvest and a September 15 planting combined with a May 1 harvest in both seasons, respectively. All planting and

harvest date combinations had sufficient TDN (>50%) to maintain dry cows (Ball et al., 1991) regardless of the season. With the exception to the November 15 planting, WW did not provide sufficient levels of TDN (>60%) to maintain a lactating cow (Ball et al., 1991) from March 1 to April 1 without supplementation in both seasons. Winter wheat provided sufficient TDN for dry cows, but it would require TDN to be supplemented when grazing lactating cows.

Table 12. Effect of planting and harvest date on dry matter yield (DMY), crude protein (%CP), total digestible nutrients (%TDN) on winter wheat in 2021-2022 and 2022-2023. USDA-NRCS, Coffeerville, MS.

Planting Date	Harvest Date (2022)								
	DMY (lbs/acre)			%CP			%TDN		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	5577 aA	7281 aA	7887 aA*	13 aB	11 aD	9 aA	64 aB	58 bD	55 bA
October 1	5199 bA	5873 abAB	7099 aA	14 aAB	13 aC	11 aA	64 aB	62 aCD	57 aA
October 15	4621 aA	4963 aB	7431 aA	17 aAB	15 abB	11 bA	70 aAB	65 bBC	57 cA
November 1	2753 aAB	4054 aB	7035 aA	18 aAB	16 aB	12 aA	71 aAB	66 abB	57 bA
November 15	767 bB*	1697 abC	2767 aB	20 aA*	20 aA	14 aA	73 aA*	71 aA	60 aA
Planting Date	Harvest Date (2023)								
	DMY (lbs/acre)			%CP			%TDN		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	2229 aA	4903 aA*	4268 aA	10 aA	9 aB	8 aD	56 aA	56 aB	53 aD
October 1	2343 bA	4397 aA	3487 abAB	11 aA	8 bB	8 bCD	57 aA	56 aB	54 aCD
October 15	2321 aA	3548 aAB	3156 aAB	11 aA	10 aAB	10 aC	58 aA	59 aAB	56 aBC
November 1	845 aB	1615 aBC	1722 aB	13 aA	12 aAB	11 aB	61 aA	61 aA	57 aB
November 15	321 aB*	941 aC	1145 aB	17 aA*	13 aA	13 aA	66 aA*	63 aA	61 aA

*Means within row for a planting date followed by the same lower-case letters and within columns for a harvest date followed by the same upper-case letters are not significantly different at $P < 0.05$ according to Tukey's HSD all pairwise comparisons test

Acid detergent fiber (ADF) decreased with later planting and/or earlier harvest dates (Table 13). For example, WW planted on November 15 and harvested March 1 (14%) 2022 and April 1 (20%) 2023 had the lowest 1 ADF when harvested in their respective seasons (Table 13). These harvest dates correspond to the tillering growth stage (Table 11). However, the highest ADF was achieved with a November 1 planting and a May 1 harvest in 2021-2022 (31%) and 2022-2023 (31%) (Table 13) which corresponds with the soft dough stage in both seasons (Table 11). There was a significant increase in ADF from tillering to stem elongation to the reproductive stage. A similar trend was reported by Keles et al. (2017) which reported cereal grains had higher nutritive value (lower ADF) at the tillering and stem elongation growth stages. To decrease ADF and preserve forage quality, graze or harvested prior to the soft dough stage.

Winter wheat experienced a significant increase in neutral detergent fiber (NDF) when harvest was delayed until May 1 within the same planting date (Table 13). For instance, the highest NDF were achieved with a May 1 harvest combined with an October 15 (63%) and September 15 (59%) harvest in 2021-2022 and 2022-2023. These planting and harvest date combinations correspond to the soft dough stage (Table 11) indicating NDF and forage quality tends to decrease as WW continues beyond the tillering and stem elongation stages of development as reported by Keles et al. (2017). However, the lowest NDF value was achieved with a November 15 planting combined with a March 1 (33%) and April 1 (37%) harvest in 2021-2022 and 2022-2023, respectively. From March 1 to April 1 of both seasons, WW was highest in the tillering growth stage. To maintain lower f NDF, it is recommended WW be grazed or harvested prior to soft dough stage.

Relative forage quality (RFQ) decreased with earlier planting and/or later harvest (Table 13) resulting from the increase maturity (Table 13). Relative forage quality ranged from 215 to 89 in 2021-2022 and from 167 to 89 in 2022-2023 with the highest RFQ achieved with a November 15 planting and a March 1 harvest in both seasons (Table 13). Winter wheat planted on November 15 and harvested March 1 corresponded with the tillering growth stage in 2021-2022 and 2022-2023 (Table 11). The lowest RFQ value was achieved with a September 15 and a May 1 harvest in 2021-2022 (89) and 2022-2023 (89) which corresponds with the soft dough stage. Winter wheat planted from October 1 to November 15 had premium to good RFQ (Appendixes 1) when harvested on March 1 and April 1 in 2021-2022 and 2022-2023. Relative forage quality of WW planted September 15 were within the premium/good category March 1, fair on April 1, and utility on May 1 for both seasons (Appendixes 1). Only

winter wheat planted on November 1 and November 15 maintained fair RFQ when harvested May 1 in 2021-2022 and 2022-2023. Relative forage quality was within the range of dry cows (Appendixes 2) regardless of planting date of March 1 and April 1 harvest dates. The Relative forage quality needed for lactating beef cows (Appendixes 2) were achieved when WW was planted from October 1 to November 15 and harvested March 1 to April 1. However, RFQ were unsuitable for lactating/dry cows when harvested May 1 regardless of planting date without sufficient supplementation. To provide sufficient RFQ for lactating cows, plant between October 1 and November 15 to obtain a grazing and/or harvesting period from March 1 to April 1 without providing supplementation to meet the nutritional needs of the class of livestock (Appendixes 2).

Table 13. Effect of planting date and harvest date on acid detergent fiber (%ADF), neutral detergent fiber (%NDF), and relative forage quality (RFQ) of winter wheat in 2021-2022 and 2022-2023. USDA-NRCS, Coffeerville, MS.

Planting Date(s)	Harvest Date (2022)								
	%ADF			%NDF			RFQ		
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	20 aA	27 aA	30 aB	44 bA	53 abA	61 aA	143 aB	107 abD	89 bA
October 1	21 aA	25 aAB	31 aAB	44 bA	51 abAB	62 aA	142 aB	117 aCD	89 aA
October 15	16 bA	22 abAB	31 aA	37 bB	49 abABC	63 aA*	183 aAB	130 abBC	89 bA
November 1	15 cA	22 bAB	31 aA*	34 cB	45 bBC	62 aA	205 aAB	144 bAB	90 cA
November 15	14 cA	20 bB	30 aAB	33 cB-	43 bC	57 aB	215 aA*	163 bA	102 cA
Planting Date(s)	Harvest Date (2023)								
	March 1	April 1	May 1	March 1	April 1	May 1	March 1	April 1	May 1
September 15	30 aA	27 aA	31 aA	50 bA	51 bA	59 aA*	111 aA	106 aB	89 bB
October 1	30 aA	26 aAB	30 aAB	49 bA	49 bA	58 aA	114 aA	113 aB	92 aB
October 15	27 aA	24 aB	28 aAB	46 bA	47 bA	56 aA	124 aA	122 aB	98 bAB
November 1	27 aA	22 aC	31 aAB*	41 bA	40 bB	59 aA	145 aA	151 aA	96 aAB
November 15	25 aA	20 aC	28 aB	39 aA	37 aB-	55 aA	167 aA*	164 aA	108 aA

*Means within row for a planting date followed by the same lower-case letters and within columns for a harvest date followed by the same upper-case letters are not significantly different at $P < 0.05$ according to Tukey's HSD all pairwise comparisons test.

CONCLUSION

Black-seeded oats had higher dry matter when planted between September 15 to October 15 and harvest was delayed until May 1. Crude protein and TDN decreased with earlier planting date and/or later harvest date. Acid detergent fiber and NDF increased with early planting and later harvest dates. Relative forage quality was premium to fair regardless of planting or harvest date. Black-seeded oats planted between October 15 and November 15 had sufficient RFQs when harvested between March 1 and April 1 for lactating beef cows (115-130) and stocker cattle (125-140).

Dry matter yields were higher for cereal rye in 2021-2022 than 2022-2023. Cereal rye planted between September 15 to October 15 had higher dry matter yields than November 1 and November 15 plantings. Crude protein and TDN were sufficient for dry pregnant beef cattle when harvested between March 1 and April 1. Relative forage quality was good to fair regardless of planting date when harvested between March 1 and April 1. However, CR terminated after April 1 would require heavy supplementation to meet the nutrient requirements of both dry and lactating cattle.

Winter triticale had higher dry matter yields in 2021-2022 compared to 2022-2023. Regardless of the season, winter triticale had higher dry matter yields when planted between September 15 and October 15. Crude protein and TDN decreased with earlier planting and/or later harvest dates. Acid detergent fiber and NDF increased with earlier planting and/or later harvest dates. Relative forage quality was suitable for lactating beef cattle and stocker cattle when TRI was planted between November 1 and November 15 when combined with a March 1 to April 1 grazing or cutting.

Dry matter yields for winter wheat were higher in 2021-2022 than 2022-2023. Nevertheless, WW had higher dry matter yields when planted between September 15 and October 15. Crude protein did not decrease substantially as WW maturity increased. Total digestible nutrient did decrease with earlier planting and/or later harvest dates. Acid detergent fiber and NDF increased as the plants matured. Relative forage quality for was

sufficient for supporting lactating beef cows and stock cattle when planting between November 1 and November 15 combined with a grazing or harvest period from March 1 to April 1.

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APPENDIX

Appendixes 1. The categories and Relative forage quality (RFQ) ranges in the Southeastern Forage Quality categorization system.

Forage Quality Category	RFQ
Premium	≥140
Good	110-139
Fair	90-109
Utility	<90

(adapted from Hancock, 2011)

Appendixes 2. The Relative Forage Quality (RFQ) ranges that are suitable to various livestock classes.

Livestock Classes	RFQ range
Dairy cow 1 st 120 days	≥140
Dairy (last 200 days)/Stocker cattle	125-140
Lactating beef cow	115-130
Dry cow	100-115

(adapted from Hancock, 2011)

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