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Interseeding crabgrass and berseem clover into sorghum–sudangrass for improved herbage accumulation, nutritive value, and weed suppression

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Abstract

Sorghum–sudangrass hybrids (*Sorghum. bicolor* × *Sorghum. bicolor var. sudanense;* SSG) are common warm-season annual forages utilized in forage systems in the northeastern United States. However, weed control can be an issue, particularly in low-input forage systems. Interseeding annual forages, such as crabgrass (*Digitaria sanguinalis* L.; CG) and berseem clover (*Trifolium alexandrinum* L.; BC), is of interest to aid in weed control due to their rapid growth and desirable nutritive value. A 2-year small plot evaluation was conducted to determine the agronomic benefits of interseeding CG and BC via no-till drill or broadcast seeding into SSG established on different row spacings. Total herbage accumulation (HA) did not differ by year for any of the treatments evaluated ($p > 0.13$), despite having different row spacing and companion crop establishment methods. Botanical composition (BOT) varied among treatments ($p < 0.01$) for all forage components in both years. In 2022, treatments containing CG had lower percentage of SSG, BC, and weeds (other undesirable plant species), but in 2023 only the weeds percentage was lower in treatments with CG. Crude protein did not differ in either year ($p > 0.55$) across treatments; however, treatments containing high amounts of CG had the lowest ($p = 0.03$) total digestible nutrients in 2022 only. This study concluded that while row spacing and the interseeding of annual forage species did not affect the overall HA of SSG, they did affect the BOT and nutritive value of the stand. Future research is warranted for evaluating other compatible forages and contrasting defoliation methods to determine their impact on the agronomic production of these types of mixtures, such as grazing or stored forage production.

Abbreviations: BC, berseem clover; BOT, botanical composition; CG, crabgrass; CP, crude protein; DM, dry matter; HA, herbage accumulation; NDF, neutral detergent fiber; NIRS, near infrared spectroscopy; NV, nutritive value; SSG, sorghum-sudangrass; TDN, total digestible nutrients.

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Plain Language Summary

Sorghum–sudangrass (SSG) is a common warm-season annual forage used throughout the world in forage systems. Interseeding crabgrass (CG) and berseem clover (BC) may aid in weed suppression, especially when SSG is planted on a wider row spacing (7.5 inches vs. 15 inches). Additionally, the establishment method (no-till drill vs. broadcasting) used for CG and BC could potentially affect the overall herbage accumulation (HA) of the SSG sward. The objective of this study was to determine the benefits of interseeding CG and BC by two methods into SSG planted on two different row spacings to the overall HA and weed suppression potential. The total HA was not affected by the interseeding method or forage. Results indicated that CG was effective at reducing competition from other non-desirable plant species. Conversely, BC did not compete well when interseeded into SSG when planted alone or in addition to CG.

1 | INTRODUCTION

Sorghum–sudangrass (*Sorghum bicolor* × *Sorghum bicolor var. sudanense*; SSG) is a warm-season annual forage commonly used in the northeastern United States, with high herbage accumulation (HA) and heat and drought tolerance (Dillard et al., 2018; Harmon et al., 2019; Pedersen & Toy, 1997). However, weeds can be an issue in SSG monocultures (Curtis & Duppstadt, 2023). Interseeding other annual forage species into SSG may suppress weeds by acting as a living mulch, similar to what is used in commodity row crop production (Bhaskar et al., 2021; De Haan et al., 1994; Mohammadi, 2012; Quinby et al., 2023). A wider row spacing may be beneficial when interseeding a companion forage to aid in weed suppression and improved HA, which has been shown in grain production (Hewitt, 2015; Sorghum Checkoff, 2021).

Warm-season annual grasses such as crabgrass (*Digitaria sanguinalis* L.; CG) can potentially be used as a living mulch in annual forage systems. Often considered a weed, CG has several desirable forage characteristics, including rapid establishment, drought tolerance, high preference, and proficient reseeding ability (Abaye, 2019; Ball et al., 2007; Blount et al., 2003) and can be grown in the Northeast (Rice, 2022; Weinert-Nelson et al., 2022).

Incorporating legumes into SSG swards may be beneficial, as they can provide both increased HA and N fixation (Biermacher et al., 2012; Ledgard & Steele, 1992). Berseem clover (*Trifolium alexandrinum* L.; BC) is an annual legume that can be grown in temperate regions, establishes in the spring and contributes 70–150 lbs acre^{-1} of soil N fixation when grown as a monoculture (Pettit & Haller, 2021; Reed & Duiker, 2024), which may make it a complementary companion forage for SSG and CG. However, there is a paucity of research evaluating the potential of BC and CG to serve as a living mulch for weed suppression in SSG swards.

Therefore, the objective of this study was to understand the agronomic benefits of interseeding CG and BC by two methods (broadcast seeding vs. no-till) into SSG planted on two different row spacings (7.5 inches vs. 15 inches). It is hypothesized that SSG production will not be negatively affected by the inclusion of annual forages when SSG is planted using a wider row spacing.

2 | LOCATION AND FORAGE MANAGEMENT

This experiment was conducted from June to September in 2022 and 2023 at the Russell E. Larson Agricultural Research Center, Pennsylvania Furnace, PA, USA (40° 43′ N, 77° 56′ W; elevation 1214 ft). Soils at this site are classified as Hagerstown silt loam soil (fine, mixed, semiactive, mesic Typic Hapludalf), with an initial soil pH of 5.8. The experimental area was fertilized prior to field preparation in May of each year with dairy manure injected at a rate of 5,000 gal acre^{-1} in 2022, and 3,000 gal acre^{-1} in 2023 based on fertilizer recommendations (PennState Extension, 2022). The dairy manure consisted of 145 lbs acre^{-1} of total N, 55 lbs acre^{-1} of total phosphate, and 125 lbs acre^{-1} of potash.

Weather was monitored using an on-site weather station as part of the National Water and Climate Center (USDA-NRCS, 2024). Average ambient temperatures (Figure 1A) and total monthly rainfall (Figure 1B) were compared to the 30-year average (NOAA, 2024). Total rainfall varied in timing and volume during the experimental period.

The experiment was arranged in a randomized complete block design with three replications (Table 1). Treatments consisted of SSG planted on two different row spacings (7.5 inches or 15 inches), with four forage combinations interseeded with SSG (SSG monoculture, CG, BC, or CG+BC),

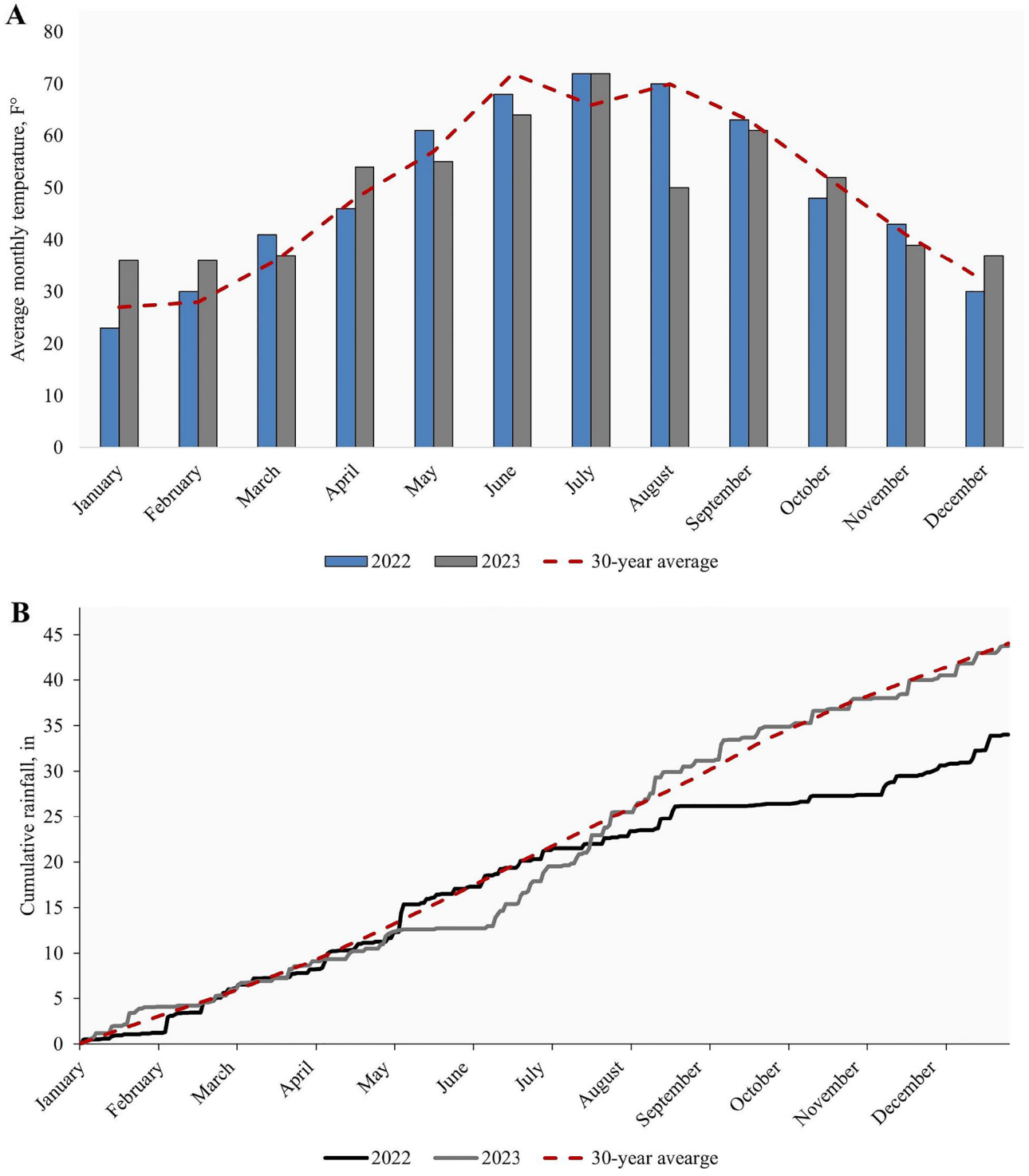


FIGURE 1 Average monthly temperature (A) and cumulative monthly rainfall (B) at Pennsylvania Furnace, PA, for 2022 and 2023 (USDA-NRCS, 2024) compared to the 30-year average (NOAA, 2024).

in which the companion forage was established using two methods: broadcast (7.5- and 15-inch row spacings) or drilled (15-inch row spacing only). This resulted in 11 treatment combinations within each block, for 33 total plots that measured 12-ft by 25-ft individually. A 30-ft alley way was maintained between each block.

Prior to study initiation in 2022, the plot area was cultivated and sprayed with 21.4 lbs acre^{-1} of glyphosate [*N*- (phosphonomethyl) glycine] to remove a cover crop of oat (*Avena sativa* L.). In both years, a conventional seedbed was prepared by shallow (~4.5-inch) disking followed by cultimulching until smooth, in preparation for planting. Sorghum–sudangrass (AS

TABLE 1 Treatment descriptions for sorghum–sudangrass (SSG) established on two different row spacings, and interseeded with crabgrass (CG) or berseem clover (BC) that was established via differing methods during 2022 and 2023 in Pennsylvania Furnace, PA.

Forage treatment	Row spacing (inches)	Interseeding method
SSG	7.5	–
SSG+CG	7.5	Broadcast
SSG+BC	7.5	Broadcast
SSG+CG+BC	7.5	Broadcast
SSG	15	–
SSG+CG	15	Drilled
SSG+BC	15	Drilled
SSG+CG+BC	15	Drilled
SSG+CG	15	Broadcast
SSG+BC	15	Broadcast
SSG+CG+BC	15	Broadcast

6401) was planted at rate of 30 lbs acre^{-1}, using a no-till drill (Tye Pasture Pleaser, AGCO Inc.), on either a 7.5- or 15-inch row spacing, to a depth of 0.5-inches. Crabgrass ('Quick-n-Big'; Dalrymple Farms, 2014) and BC ('Frosty'; King's AgriSeeds, 2021) were planted to a depth of 0.25 inches, at a rate of 2 lbs acre^{-1} and 10 lbs acre^{-1}, respectively.

No-till treatments were planted at the same time as SSG using the large seed box for the SSG and the small seed box for the CG and BC. Alternate rows were taped off in each box to ensure correct row spacing was maintained. In broadcast plots, CG and/or BC seed were first broadcast using a Brillion cultipacker seeder (Landoll Company, LLC), followed by the SSG being planted using the no-till drill previously described. All forages were planted on June 13, 2022, and only SSG and BC were planted on June 8, 2023. Crabgrass was only planted in 2022 because of its proficient reseeding ability (Ball et al., 2007; Blount et al., 2003). Therefore, after CG had produced seed on November 1, 2022, a rotary hoe was used to scratch the soil surface to ensure seed incorporation into the soil.

3 | DATA COLLECTION AND ANALYSIS

Harvest dates for 2022 were July 21, August 10, and September 27, and harvest dates for 2023 were July 26 and September 18. Significant weather events, specifically reduced precipitation conditions during the experimental period of 2023 (~8% less than the 30-year average during the experimental period) resulted in increased days between harvests compared to 2022 due to slower forage regrowth, resulting in only two harvests that year (Figure 1B). Plots were harvested when SSG was ~35-inches tall to a 7.5-inch harvest height using a 5-ft-wide sickle bar small plot harvester with a scale attachment (HEGE 212, Wintersteiger) from the center of the plot. Two subsamples (~2 lbs) of fresh material were collected from each plot at each harvest. One subsample was collected for determining botanical composition (BOT) which was hand-separated into SSG, CG, BC, and weeds (all other plant species). The second subsample was used for dry matter (DM) determination of HA and nutritive value (NV). All forage samples were dried at 130°F in a forced-air oven for 72 h and then weighed to correct for moisture. The dry weights of the first subsample were used to calculate BOT, while the dry weights of the second subsample were used to determine the HA, before being ground for NV analysis. All residual forage was removed from plots using the same harvester.

After drying, HA samples were ground to pass through a 0.04-inch sieve using a Wiley Mill (Thomas-Wiley Laboratory Mill, Thomas Scientific) before they were then ground to pass through a 0.04-inch sieve using a Retsch Twister Cyclone Sample Mill, (Verder Scientific) in preparation for NV analysis via near infrared reflectance spectroscopy (NIRS; McIntosh et al., 2022). Forage samples were analyzed for DM, crude protein (CP, % of DM), and neutral detergent fiber (NDF, % of DM) using the 2023 Grass Hay calibration equations provided by the NIRS Forage and Feed Testing Consortium (NIRSC, 2023). Samples were analyzed using a Foss DS3F NIR spectrometer (Foss Analytical) that was standardized to the NIRCS master instrument to ensure prediction accuracy. Nutritive data are reported with predictions fitting the allowable H < 3.0 (Murray & Cowe, 2004). Total digestible nutrients (TDN) were calculated using Equation 1 below for grass monocultures (NRC, 2001):

$$\text{TDN} = (\text{NFC} * 0.98) + (\text{CP} * 0.87) + (\text{FA} * 0.97 * 2.25) + \left[\text{NDFn} * \left(\frac{\text{NDFDp}}{100}\right)\right] - 10 \quad (1)$$

where NFC = non-fibrous carbohydrate (% of DM), FA = fatty acids (% of DM), NDFn = nitrogen free NDF (% of NDF), and NDFDp = 48-h in vitro NDF digestibility point. All values used in the calculation of TDN come from the NIRS analysis, where FA = ether extract − 1, NFC = 100 − (NDFn + CP + ether extract + ash), NDFn = NDF × 0.93, NDFDp = 22.7 + 0.664 × NDFD, and NDFD = 48-h in vitro NDF digestibility (% of NDF) (Undersander et al., 2010). A subset (15%; $n = 22$) of samples were randomly selected from each harvest for validation of NV parameters. Samples were analyzed via wet chemistry for CP (AOAC, 2000) and NDF (Van Soest et al., 1991) at Cumberland Valley Analytical Services (Waynesboro, PA). The standard error of prediction (SEP) for CP was 0.71 and for NDF was 1.71, while the coefficient of determination (R^2) for cross validation was 0.99 and 0.94, respectively.

Data were analyzed by restricted maximum likelihood using PROC MIXED in SAS v9.4 (SAS Institute Inc.; Littell et al., 2006). A Kenwood–Rogers adjustment was used to correct the denominator degrees of freedom and ensure

TABLE 2 Mean herbage accumulation for sorghum-sudangrass (SSG) established on two different row spacings, and interseeded with crabgrass (CG) or berseem clover (BC) that was established via differing methods during 2022 and 2023 in Pennsylvania Furnace, PA.

Forage treatment	Row spacing	Interseeding method	Herbage accumulation	
			2022	2023
	inches		lbs acre^{-1}	
SSG	7.5	–	6831	5610
SSG+CG	7.5	Broadcast	7299	5825
SSG+BC	7.5	Broadcast	7153	5838
SSG+CG+BC	7.5	Broadcast	7559	6778
SSG	15	–	7928	5339
SSG+CG	15	Drilled	7844	6503
SSG+BC	15	Drilled	6704	6227
SSG+CG+BC	15	Drilled	7727	6023
SSG+CG	15	Broadcast	7442	6196
SSG+BC	15	Broadcast	7618	6507
SSG+CG+BC	15	Broadcast	7234	6761
		SEM	462.4	728.2

Note: Means within a column without common superscripts differ ($p \leq 0.05$).
Abbreviation: SEM, standard error of the mean.

appropriate standard errors and F statistics for each tested model. The Autoregressive (1) covariance structure was determined to be the best fit for these models based on the lowest Bayesian's Information Criterion (Littell et al., 2006). The subject of the repeated measures was experimental unit within each year. Herbage accumulation data were analyzed by year across all harvest periods due to the variation in the number of harvests each year. Year, SSG row spacing, and interseeding method were considered fixed effects, with block being considered a random effect. Botanical composition and NV parameters were analyzed by year and across harvest cycles. Fixed effects included year, SSG row spacing, and interseeding method, with block being considered a random effect. Means were compared using the LSMEANS procedure with Tukey–Kramer adjustment ($p \leq 0.05$). Differences were considered significant at $p \leq 0.05$. Because of the large number of treatment combinations in this study, the main effect means (i.e., row spacing, inclusion of companion species) were compared by a single degree of freedom contrasts to isolate the importance of each treatment component.

4 | RESULTS AND DISCUSSION

4.1 | Herbage accumulation

Total HA did not differ among treatments in 2022 ($p = 0.65$) or 2023 ($p = 0.91$; Table 2). Additionally, contrasts were evaluated among the mean HA for treatments for each respective effect. Contrasts comparing row spacings, forage mixtures, interseeding methods, and their combinations were not different from each other ($p > 0.13$) and are provided in Appendix A.

While literature does not exist that evaluates HA of SSG interseeded with CG and/or BC, these results are similar to Nave and Corbin (2018) and Nave et al. (2020) for corn (*Zea mays* L.) interseeded with annual legumes and CG, and SSG interseeded with cowpea (*Vigna unguiculata*), respectively. Nave and Corbin (2018) reported that total HA was not affected by interseeding annual legumes and CG into corn grown for silage. Similarly, Nave et al. (2020) reported no differences in total HA in SSG grown in monoculture or interseeded with different rates of cowpea.

4.2 | Botanical composition

The overall BOT percentage of SSG ($p < 0.01$) differed among forage treatments in 2022 (Table 3). However, no differences were observed for the percentage of SSG in each forage treatments in 2023 ($p = 0.90$; Table 3).

This year effect was attributed to the weather conditions experienced during the experimental periods (Figure 1A, B). During 2022, the SSG monocultures at both row spacings and all SSG plots interseeded with BC only had the greatest percentage of SSG (~20% more) compared to SSG plots interseeded with CG via broadcasting. Mercier et al. (2021) evaluated sudangrass (*Sorghum* × *drummondii*) planted at 50 lbs acre^{-1} which is greater than SSG in the current study in a 12-species summer annual mixture in Kentucky. They reported that CG comprised a smaller portion of the total

TABLE 3 Mean botanical composition and nutritive value for sorghum-sudangrass (SSG) established on two different row spacings, and interseeded with crabgrass (CG) or berseem clover (BC) that was established via differing methods during 2022 and 2023 in Pennsylvania Furnace, PA.

			Botanical composition				Nutritive value		
Forage treatment	Row spacing	Interseeding method	SSG	CG	BC	Weeds	CP	NDF	TDN[a]
	inches		%						
2022									
SSG	7.5	–	87.4a	–	–	12.6	16.7	58.1	64.9ab
SSG+CG	7.5	Broadcast	38.9b	51.6a	–	9.5	14.0	58.3	62.9bcd
SSG+BC	7.5	Broadcast	89.4a	–	7.7a	5.5	16.7	57.6	65.3a
SSG+CG+BC	7.5	Broadcast	45.0b	50.3a	1.7b	3.6	15.3	58.0	63.2abcd
SSG	15	–	94.0a	–	–	6.0	17.0	58.0	65.2a
SSG+CG	15	Drilled	73.8a	21.4b	–	4.8	14.9	58.4	63.2abcd
SSG+BC	15	Drilled	92.5a	–	2.6b	5.0	16.0	58.7	64.8abc
SSG+CG+BC	15	Drilled	79.4a	16.7b	1.7b	2.8	14.1	58.5	63.3abcd
SSG+CG	15	Broadcast	49.7b	48.5a	–	1.8	14.0	58.6	62.7 cd
SSG+BC	15	Broadcast	90.7a	–	4.7ab	4.7	16.5	58.5	64.6abc
SSG+CG+BC	15	Broadcast	45.5b	47.4a	1.6b	6.0	13.7	59.6	62.1d
		SEM	4.08	5.03	0.89	2.67	1.45	0.92	0.82
2023									
SSG	7.5	–	50.0	–	–	50.0a	9.1	62.8	60.0
SSG+CG	7.5	Broadcast	48.5	35.8	–	15.7bc	9.0	62.7	59.6
SSG+BC	7.5	Broadcast	54.7	–	5.9	39.3abc	9.4	63.3	59.8
SSG+CG+BC	7.5	Broadcast	48.6	43.1	3.0	7.1c	9.8	65.2	59.5
SSG	15	–	43.8	–	–	56.2a	10.0	62.0	58.6
SSG+CG	15	Drilled	45.0	39.4	–	15.6bc	9.2	64.0	59.1
SSG+BC	15	Drilled	55.9	–	8.7	35.5abc	9.3	63.0	59.9
SSG+CG+BC	15	Drilled	45.1	42.9	2.5	9.4c	9.7	64.9	59.3
SSG+CG	15	Broadcast	42.1	47.2	–	9.0c	9.3	64.0	59.1
SSG+BC	15	Broadcast	46.6	–	5.8	47.6ab	9.8	62.4	59.2
SSG+CG+BC	15	Broadcast	47.4	40.6	1.5	10.3c	9.8	63.6	59.2
		SEM	7.00	8.05	–	7.83	0.66	1.87	0.47

Note: Means within a year within a column without common superscripts differ ($p \leq 0.05$).

Abbreviations: CP, crude protein; NDF, neutral detergent fiber; SEM, standard error of the mean; TDN, total digestible nutrients.

[a]Total digestible nutrients = (NFC × 0.98) + (CP × 0.87) + (FA × 0.97 × 2.25) + [NDFn × (NDFDp/100)] − 10.

mixture (<8%), while legumes poorly competed with the larger summer annual grasses (Mercier et al., 2021).

Similarly, differences were observed in 2022 for the percentage of CG ($p < 0.01$) that were not observed in 2023 ($p = 0.74$; Table 3). Again, weather conditions affected the forage production of these mixtures. The CG composition in 2022 was affected by both SSG row spacing and the interseeding method utilized (Table 3). In SSG plots seeded at 7.5-inch row spacing, broadcasting CG+BC resulted in the greatest CG percentage in comparison to both drilling CG+BC or CG into 15-inch SSG rows. All other forage treatments containing CG were intermediate to the previously mentioned treatments. Overall, broadcasting CG resulted in a higher percentage of CG compared to drilling CG. This is supported by previous research that recommends broadcasting CG because of the proficient ability of CG to spread over a large area (Dalrymple Farms., 2014; Fike et al., 2019). The authors note that while CG does have a proficient ability to spread, they did not observe its encroachment into plots not interseeded with CG. However, it is anticipated that if this study was conducted for another year, there would have been presence of CG in the entire experimental area.

In general, BC was a minor component (<8%) when interseeded into SSG plots. Despite this, in plots containing BC, both row spacing and interseeding method affected BC percentage only in 2022 ($p < 0.01$) but not in 2023 ($p = 0.09$;

Table 3). In 2022, plots where BC only was planted (drilled or broadcast) into SSG using both 7.5- and 15-inch rows, there was a greater percentage of BC compared to all other plots in which CG+BC were planted, which were similar to each other. The rapid establishment and growth of CG likely outcompeted BC when interseeded together. Berseem clover is also not as shade tolerant (Ehert et al., 2015; Pettit & Haller, 2021), and both SSG and CG have vigorous growth habits which are conducive to producing shade (Fike et al., 2019).

All previously mentioned forage components affected the concentration of weed species in the stand, in that no differences were observed in 2022 ($p = 0.17$) but did differ in 2023 ($p < 0.01$; Table 3). The most common weed components were lambsquarters (*Chenopodium album*) and yellow nutsedge (*Cyperus esculentus*). Despite different row spacings, both SSG monoculture treatments resulted in the highest weed component in 2023 and were similar to plots interseeded with BC due to the non-competitiveness of BC as previously described.

4.3 | Nutritive value

Treatment did not affect CP or NDF values in 2022 ($p = 0.55$ and $p = 0.95$, respectively) or in 2023 ($p = 0.99$ and $p = 0.96$, respectively; Table 3). Unlike the current study, Nave et al. (2020) observed differences for CP when cowpea was incorporated into SSG. Moreover, Nave and Corbin (2018) reported that corn interseeded with CG harvested for silage had both a lower CP and higher NDF than corn interseeded with a legume. Their average CP and NDF values are similar to the plots interseeded with CG in the current study (Nave & Corbin, 2018).

The observed TDN was different among forage treatments only in 2022 ($p = 0.03$) but not in 2023 ($p = 0.64$; Table 3). In 2022, despite differing row spacings and interseeding methods, plots interseeded with CG only had lower TDN values compared to plots in which BC was broadcast into SSG on a 7.5-inch row spacing (Table 3). Additionally, broadcasting CG+BC into SSG on a 15-inch row spacing differed only from plots containing SSG grown in monoculture and SSG+BC. Berseem clover also had a very minor contribution to overall BOT of these mixtures, which may have resulted in similar CP concentrations being observed (Table 3).

Differences in TDN likely resulted from the CG maturing faster, thus producing a seedhead while other forages were still in a vegetative state. This could be a challenge when using CG, since all harvests were based on SSG maturity as it has the higher HA potential. While not measured, it was observed that the CG component was at the reproductive stage/anthesis while SSG was still vegetative. However, had harvests occurred following frequent defoliation to keep the CG vegetative, the SSG during the same timeframe would have been quite short and perhaps would not regrow as well.

5 | CONCLUSIONS

One of the greatest challenges with using forage mixtures is balancing species and seeding rates to achieve a mixture that meets producer goals. This study concluded that while row spacing and the interseeding of annual forage species did not affect overall HA of SSG, they did affect BOT and NV of the stand. Crabgrass provided better weed suppression than BC because of its vigorous growth habit. These mixtures should be evaluated in a grazing study, as livestock may selectively graze the CG or BC in mixed annual pastures. Other forage legumes that are more shade tolerant than BC should also be evaluated, as they may provide better weed suppression in SSG swards. Future research is warranted evaluating forages with similar maturation rates to SSG under contrasting defoliation methods and how they impact the agronomic production of these types of mixtures.

AUTHOR CONTRIBUTIONS

Justin Burt: Formal analysis; validation; writing—original draft; writing—review and editing. **Kathy J. Soder**: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; supervision; validation; visualization; writing—review and editing. **Kelly Mercier**: Conceptualization; data curation; investigation; methodology; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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APPENDIX A: Contrast statements for the herbage accumulation of sorghum–sudangrass (SSG) established on two different row spacings, and interseeded with crabgrass (CG) or berseem clover (BC) established via differing methods during 2022 and 2023 in Pennsylvania Furnace, PA.

	P-value	
Contrasts	**2022**	**2023**
7.5-inch row spacing vs. 15-inch row spacing	0.41	0.92
7.5-inch interseeded vs. 15-inch interseeded	0.64	0.35
Companion species drilled vs. broadcast	0.18	0.92
CG drilled vs. CG broadcast	0.27	0.47
BC drilled vs. BC broadcast	0.42	0.25
CG interseeded vs. monoculture	0.47	0.24
BC interseeded vs. monoculture	0.13	0.63
Mixture vs. monoculture	0.20	0.49