INTESIFIED FORAGE WINTER WHEAT PRODUCITON IMPACTS ON SOIL CHEMICAL AND PHYSICAL PROPERITIES UNDER DIFFERENT TILLAGE MANAGEMENT SYSTEMS

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ABSTRACT

Producers often take advantage of the opportunity to graze livestock on wheat during the winter and spring months, the fields are then left fallow during the summer. Interest has increased into the replacement of summer fallow periods with forage quality crops for livestock grazing. This has resulted in many questions regarding the impacts of intensive forage management on the production and sustainability of the land. This study, in conjunction with the Noble Research Institute, attempts to answer these questions. Established winter wheat grazing paddocks managed under no-till and tillage systems were used to evaluate the impact of intensification of forage cropping on the impacts of soil chemical and physical parameters. The two established tillage management systems were the primary factor of the study, within each of those were a treatment of cropping method of either summer fallow or summer forage cropping. Soil samples collected at the beginning of each winter wheat season were evaluated for the impacts of intensification by summer forage cropping. Soil bulk density and infiltration were often reduced and soluble salts were increased by the intensification of forage cropping. These impacts often decreased as the study progressed, often to a level of non-significance in final wheat season. The soil organic matter was not impacted by either summer cropping method but did show a decline following the first year of the trial. This study tells us the impact of intensive for cropping are minimal when present and become in-significant after the first 3 to 4 years in both tillage management systems.

INTRODUCTION

The common practice for annual winter wheat forage production in Oklahoma is to graze a wheat crop and follow with a summer fallow period. In order to reduce the time in which a field would not be productive, recent research has evaluated the possibility of increasing production by replacing traditional fallow periods with forage quality summer crops (Horn et al., 2020). The introduction of summer into a winter wheat system have shown beneficial for reducing erosion and nitrate losses, with increases in soil carbon, when managed properly (Blanco-Canqui et al., 2013; Blanco-Canqui & Ruis, 2020). However, increasing annual forage production could result in greater nutrient mining of the soil due to the increased biomass removal by grazing livestock. Another common practice among Oklahoma forage producers managing grazed land using traditional tillage practices, such as sweep or disc tillage, for seedbed preparation and weed management. With the increased popularity of no-till management in crop production regions, there has been interest among forage produces about implementing similar no-till management schemes. There have been reports of improvements in soil bulk density (Thomas et al., 2008) and nitrogen (N) concentrations (Franzluebbers & Stuedemann, 2014) following the introduction of no-tillage. However, similar to producing a crop during a normal fallow period, no-till management can also impact soil chemical characteristics of the soil, by introducing stratification due to eliminating soil homogenization by tillage (Crozier et al., 1999). The potential interaction between these two management practices has been investigated little, and has become of concern to researchers, as many producers look to increase production of land while reducing costs by utilizing a no-till management approach. The objective of this study is to determine and compare the soil chemical and physical property impacts of an intensified forage winter wheat grazing system under conventional and no-till management strategies.

MATERIALS AND METHODS

This study was conducted over five years (2015-2020) including both winter and summer cropping seasons near Ardmore, Oklahoma (34° 13’ 0.75” N, 97° 12’ 30.98” W). The trial area was managed as a winter wheat grazing unit for more than 30 years prior to establishment with paddock tillage management strategies in use since the 1990’s. Nitrogen management was done using Urea (46-0-0), with applications of 50 lb N ac^{-1} in the first two years, and 25 lb N ac^{-1} in the final three years of the trial. The trial was established in a winter wheat grazing, summer fallow rotation, as a randomized complete block design with a two-by-two factorial treatment structure with five replications. Treatments factors applied to replicate 5 ac grazing paddocks were the primary factor of crop residue management using either conventional tillage of multiple passes with a disc, or no tillage management system. The secondary factor of summer cropping method of either fallow or a summer crop mixture. Experimental units were managed using the best management practices for the production system, with applications of herbicides and fungicides, and animals provided with water, supplemental feed, and vaccinations as necessary.

Soil water infiltration rates were measured using a mini disk infiltrometer (Meter Group; Pullman, WA.) set at 0.8 in suction at 5 randomly selected locations in each paddock, within a three-day timeframe targeting similar soil moisture contents. Soil infiltration readings were taken in 30 second intervals for a total of 5 minutes. Bulk density measurements were taken prior to each cropping season from each paddock with five samples collected using a 5-cm diameter hammer probe (AMS Inc; American Falls, ID). The samples were then stratified by 0–2 in., 2–4 in., and 4–6 in. and oven dried at 150 °F to a constant weight. A 0–6 in. bulk density was calculated by combining the stratified samples. Standard soil test samples were collected from twelve, 1-inch cores from each paddock at the beginning of each cropping season. Soil chemical analysis was conducted using standard soil testing procedures for organic matter and soluble salt after drying soil at 150°F for up to 12 hours followed by grinding the soil to pass through a 2-mm sieve. Sampling date soil data was analyzed for crop influence within tillage management system at an alpha of 0.05. Statistical analysis was done using PROC GLM in SAS 9.4.

RESULTS AND DISCUSSION

Soil bulk density showed to be impacted by the intensification at the beginning of the 2017/18 winter wheat growing season for both tillage systems as well as the beginning of the 2018/19 winter wheat growing season in the tilled system. The beginning bulk density of the no-till system was decreased by the intensification by 0.05 g cm^{-3} in the 2017/18 and 0.12 g cm^{-3} in the 2018/19 growing season (Figure 1). The tilled system showed an increase in 2017/18 beginning bulk density of 0.22 g cm^{-3} when summer forages were used in place of a summer fallow (Figure 2).

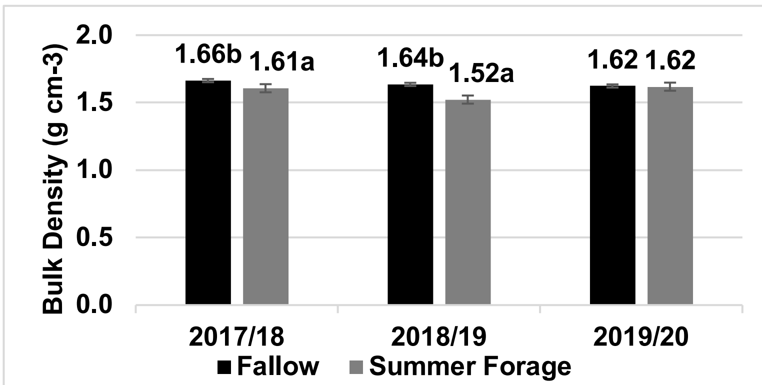

Figure 1. Soil bulk density (g cm^{-3}) taking at the beginning of each no-till winter wheat cropping season. Letters denote significant differences within sampling date.

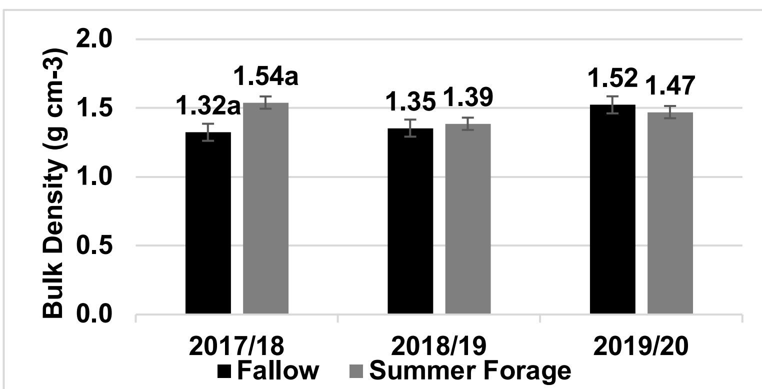

Figure 2. Soil bulk density (g cm^{-3}) taking at the beginning of each tilled winter wheat cropping season. Letters denote significant differences within sampling date.

Soil water infiltration measured at the beginning of each winter wheat season reported a significant impact of intensification in the no-till system in the 2016/17 season. The no-till system in 2016/17 had greater infiltration of surface applied water by 0.98 cm^3 $hour^{-1}$ when the summer season was fallowed compared to cropped (Figure 3). Similar intensification impacts to soil water infiltration were not observed following the 2016/17 season, however the final two no-till winter wheat seasons reported numerically greater infiltration when summers were cropped. The tilled system reported no significant impacts of intensification, but typically had greater infiltration rate when summer periods were left fallow (Figure 4).

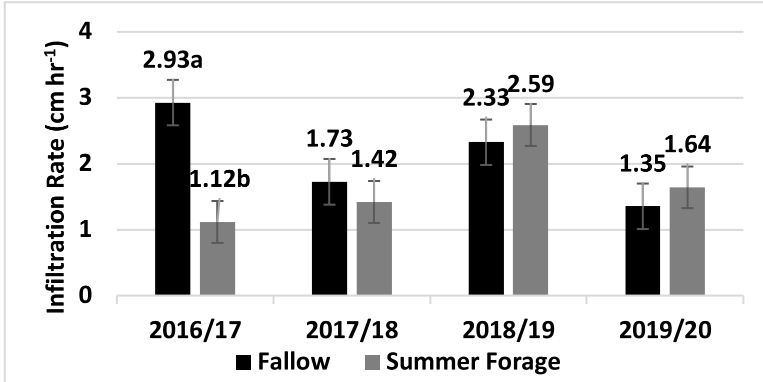

Figure 3. Soil water infiltration (cm hr $^{-1}$) taking at the beginning of each no-till winter wheat cropping season. Letters denote significant differences within sampling date.

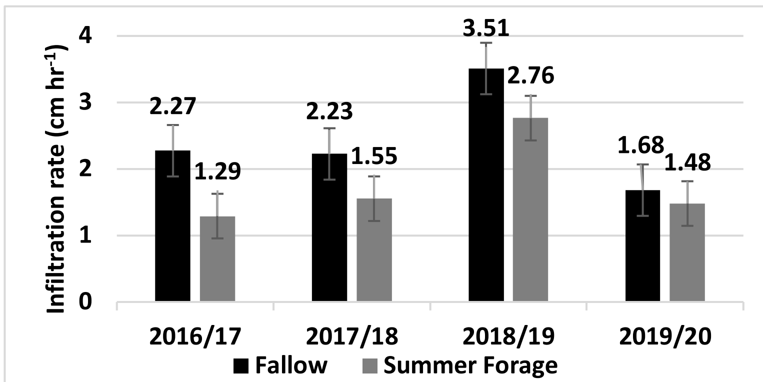

Figure 4. Soil water infiltration (cm hr $^{-1}$) taking at the beginning of each tilled winter wheat cropping season.

Soil organic matter content was not impact by intensification in either tillage system at the beginning of any winter wheat season. There was a decrease from the first recorded sampling, at the beginning of 2015/16, from an average of 2.2% in the no-till and 1.92% in the tilled systems to 1.53 and 1.17%, respectively, in the second sampling (Figure 5; Figure 6). Soil organic matter content stayed similar through the subsequent sampling dates.

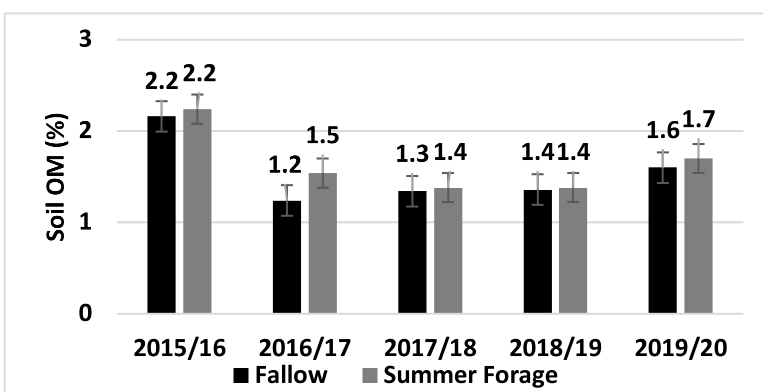

Figure 5. Soil organic matter content (%) taking at the beginning of each no-till winter wheat cropping season.

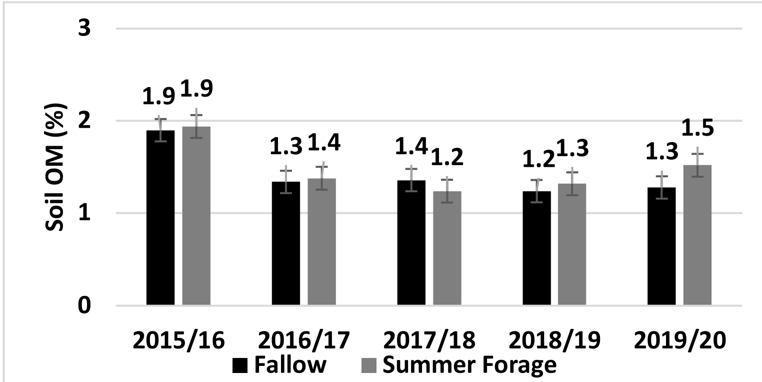

Figure 6. Soil organic matter content (%) taking at the beginning of each tilled winter wheat cropping season

Soluble salts concentration was reported to be significantly different for both tillage systems. In the no-till system were significant different in the 2016/17, 2017/18, and 2018/19 winter wheat seasons. These significant seasons all reported lower soluble salt concentrations when the previous summers were fallowed as compared to cropped with a summer forage by 42 to 63 ppm (Figure 7). Differences in the 2015/16 no-till soluble salts are non-significant (p=0.0506) and due to spatial variability, as no treatments had been applied at the time of sampling. The tilled paddocks reported intensification impacts in the 2016/17 and 2018/19 winter wheat seasons (Figure 8). Both of these seasons had 85 and 70 ppm less soluble salts in the fallow treatments than in treatments that were cropped during the summer in the 2016/17 and 2018/19 seasons, respectively.

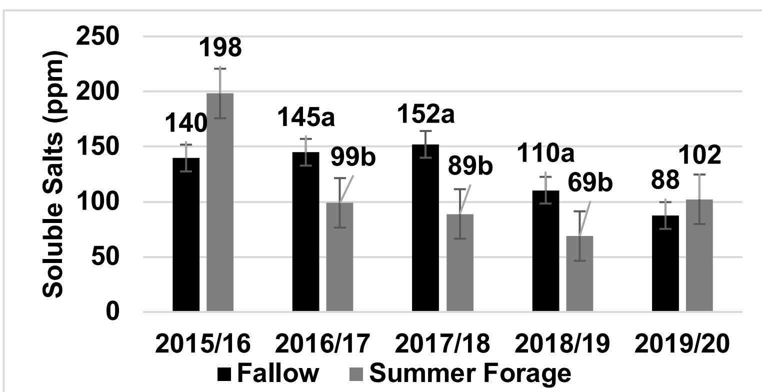

Figure 7. Soil soluble salt concentration (ppm) taking at the beginning of each no-till winter wheat cropping season. Letters denote significant differences within sampling date.

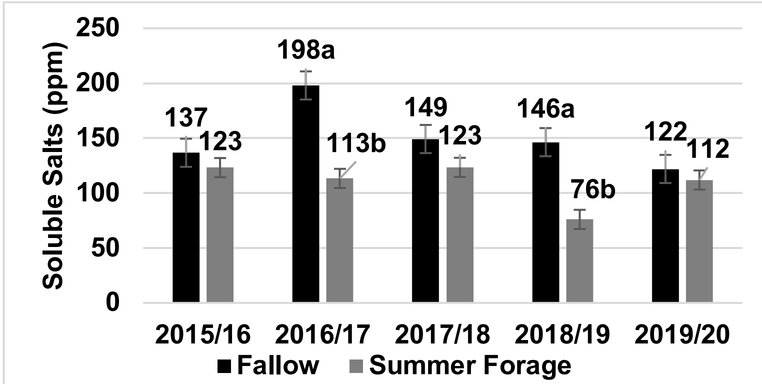

Figure 8. Soil soluble salt concentration (ppm) taking at the beginning of each tilled winter wheat cropping season. Letters denote significant differences within sampling date.

The impacts of intensification on soil properties were observed in the second, third, and occasionally fourth year of the study. As the study progressed toward a conclusion all impacts were found insignificant in the final winter wheat season in both tillage managed systems. These results echo the observations of Blanco-Canqui et al. (2013), who found the impacts of intensive cropping, by replacement of a fallow period, on soil properties to be short lived. Although this data is a small portion of a larger study evaluating the impacts of forage cropping intensification, they stand alone in showing the impacts to soil chemical and physical parameters.

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