Soil water content, CO_2 flux, and crop yields in wheat-camelina cropping system

Eric Obeng[1], Augustine K. Obour[2], Nathan O. Nelson[1], Ignacio A. Ciampitti[1], Donghai Wang[3], and Eduardo A. Santos[1]
[1]Department of Agronomy, Kansas State University, Manhattan, KS
[2]Kansas State University Agricultural Research Center, Hays, KS
[3]Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS

KANSAS STATE UNIVERSITY

Introduction

- Camelina (*Camelina sativa* L. Crantz) has been identified as a potential fallow replacement crop in dryland wheat (*Triticum aestivum*) based cropping systems in the Great Plains.
- Uses of camelina includes biodiesel, animal feed, adhesives, and anti-oxidizing agent in food processing.
- Residue return, and residue diversity is increased by cropping intensification, and has the potential to increase nutrient cycling through soil organic matter decomposition.
- Cropping sequence can affect the ability of soils to sequester carbon, and plant available water.

Objective

The objective of this study was to investigate the impact of replacing fallow with camelina on crop yields, soil water content at wheat planting, soil carbon dioxide (CO_2) flux, and residue return.

Materials and Methods

- Location: K-State Univ. Ag Research Center, Hays, KS
- Experimental design: Randomized Complete Block
- Crop rotations
  - Wheat-fallow (W-F)
  - Wheat-sorghum-fallow (W-S-F)
  - Wheat-spring camelina (W-SC)
  - Wheat-sorghum-spring camelina (W-S-SC)
- Data collection
  - Soil CO_2 flux was measured using LI-8100 automated CO_2 flux system (Li-cor Biosciences, NE, USA).
  - Soil cores (0-60 cm) were taken using soil auger, and oven dried at 105^{O}C for soil moisture content determination.
  - Ground residue cover was estimated using the stick method. Residue was collected using a quadrat and oven-dried at 65^{O}C until a stable weight was reached.
  - Winter wheat, grain sorghum, and camelina yields were determined after harvesting.
  - Camelina oil and protein content were determined using FT-NIR Near Infrared spectrophotometer (NIRS).

Fig. 1. CO_2 flux measurement in sorghum plot

Results and discussion

Table 1. Winter wheat, grain sorghum and camelina seed yields in 2015 as affected by crop rotation sequence

Crop rotation	Winter wheat	Grain sorghum	Camelina yield	Camelina protein content (%)	Camelina oil content (%)
		kg ha^{-1}			
Wheat-fallow	1742	-	-	-	-
Wheat-sorghum-fallow	1675	3217	-	-	-
Wheat-spring camelina	1560	-	908	29.6	28
Wheat-sorghum-spring camelina	1505	3115	247	29.5	28.3
Mean	1620	3166	577	29.5	28.1
LSD	524	1552	228	1.5	1.3

Table 2. Impact of crop rotation on crop residue and soil water content

Crop rotation	Residue biomass (kg ha^{-1})	Ground cover (%)	Soil moisture in 0-60 cm depth at wheat planting (cm)
Wheat fallow	**1503.6^{c}**	**67.1^{b}**	**16.50^{ab}**
Wheat-sorghum-fallow	3784.9^{a}	82.5^{ab}	18.06^{a}
Wheat-spring camelina	2194.7^{b}	82.5^{ab}	15.04^{b}
Wheat-sorghum-spring camelina	**3316.2^{a}**	**92.3^{a}**	**15.06^{b}**

Means within column followed by same letter(s) are not significantly different (*$P<0.05$*)

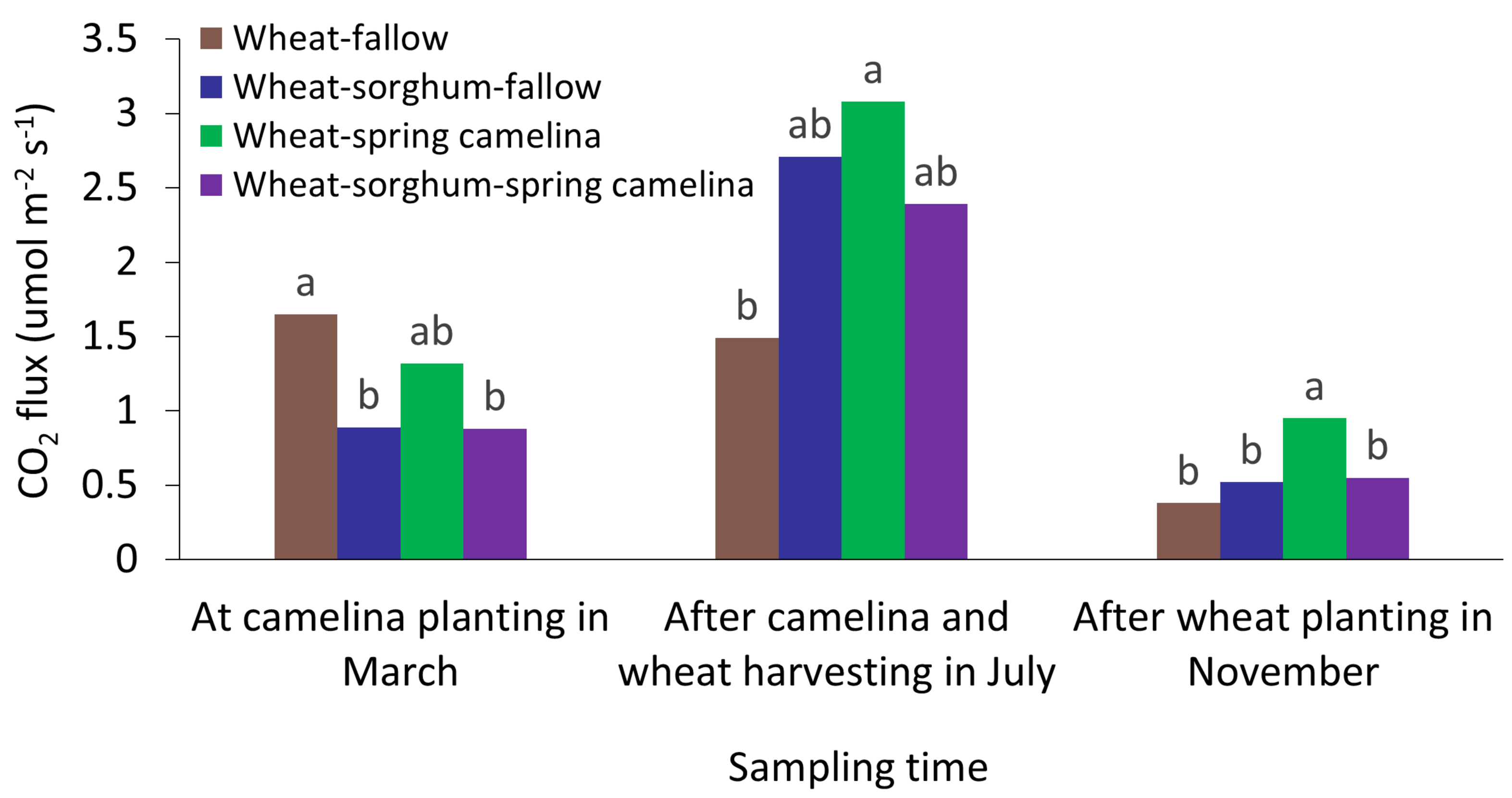

Fig. 2. Effect of crop rotation on soil CO_2 flux in 2015

Camelina, sorghum, and wheat yield

- Wheat yields were not significantly different, although wheat yields reduced with increasing cropping intensity (Table 1). This could be attributed to less moisture availability for wheat growth (Table 2).
- Spring camelina yield was 908 kg ha^{-1} when camelina was planted after wheat (W-SC), greater than 247 kg ha^{-1} when planted after sorghum (W-S-SC) (Table 1). The low yield could be attributed to more residue in W-S-SC and inadequate moisture to support spring camelina establishment (Table 2). Poor plant stands were observed in W-S-SC rotation.

Crop residue and soil moisture

- Crop residue and ground cover increased with cropping intensity (Table 2). Crop residue in W-S-F and W-S-SC were similar, but they were greater than W-F and W-SC.
- Soil moisture storage was significantly greater in W-S-F compared to W-SC, and W-S-SC, but it was not different from W-F (Table 2). Relatively more moisture storage during the fallow period in W-S-F and W-F could be the reason.

Soil CO_2 flux

- At camelina planting in March, CO_2 flux was greater in W-F, and was significantly different from W-S-F, and W-S-SC, but it was not significantly different from W-SC. This shows more soil carbon was lost from the 2-year rotation systems compared to the 3-yr rotation systems (Fig. 2). Relatively great soil moisture in the 2-yr rotation systems may have accelerated residue decomposition and CO_2 flux.
- At wheat harvest in July, CO_2 flux was more in W-SC, and was different from W-F, but it was not different from the 3-yr rotation systems i.e. W-S-F, and W-S-SC (Fig. 2). The greater CO_2 flux could be attributed to high summer temperatures, and the quality of residue contributed by the rotation systems.
- After wheat planting in November, CO_2 flux was at a seasonal low across treatments. W-SC rotation emitted more CO_2 flux and was significantly different from the other crop rotations (Fig. 2). This could be a result of decomposition of camelina residue from the past season.

Conclusion

- Increasing cropping intensity resulted in a decrease in wheat yield, but it was not different from yields obtained with W-F system.
- Camelina yield were affected by crop rotation, and may be attributed to low soil moisture availability when planted after sorghum.

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Scan for more information