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John Holman
*Kansas State University*, jholman@ksu.edu

Augustine Obour
*Kansas State University*, aobour@ksu.edu

Lucas Haag
*Kansas State University*, lhaag@ksu.edu

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# Occasional Tillage in a Wheat-Sorghum-Fallow Rotation

*John Holman, Augustine Obour, and Lucas Haag*

## Summary

Beginning in 2012, research was conducted near Garden City and Tribune, KS, to determine the effect of a single tillage operation every 3 years on grain yields in a wheat-sorghum-fallow (WSF) rotation. Treatments included no-till, single tillage post wheat harvest in mid-August, and single tillage in mid-June during the fallow phase. This study was revised with the addition of two more intensive tillage treatments since 2019. The two additional treatments were 1) two tillage operations during the fallow phase, and 2) one tillage during fallow phase and one tillage post wheat harvest. Grain yield varied greatly by year and location. Wheat yields ranged across years from mid-20s to 90 bu/a at Tribune and less than 10 to 100 bu/a at Garden City. Grain sorghum yields ranged from 40 to greater than 140 bu/a, depending upon year and location. Drought and hail at Garden City resulted in several years of no harvestable grain sorghum at Garden City. Wheat yields were greater when tillage occurred during the fallow phase at Garden City. There were no differences in wheat yield at Hays or Tribune. Grain sorghum yield was greater in no-till at Tribune. There were no differences in grain sorghum yield at Garden City or Hays. There are some year-by-treatment differences, and treatment differences might be increasing over time. For these reasons, more years of data are needed. Currently, this study supports the hypothesis that if herbicide-resistant weed populations are a challenge, an occasional tillage operation will have little effect on crop yield.

## Introduction

Previous research showed lower dryland wheat and grain sorghum yields with reduced tillage compared with no-tillage in a wheat-sorghum-fallow (WSF) rotation near Tribune, KS (Schlegel et al., 2018). The reduced tillage systems generally used four or more tillage operations in the 3-year rotation. With the increased incidence of herbicide-resistant weeds, the use of a complete no-tillage system may not be economical, and tillage may be needed for effective control. The objective of the research project is to determine the effect of occasional tillage (1-2 tillage operations every 3 years) on wheat and grain sorghum yields in a WSF rotation.

## Procedures

Research on occasional tillage in a WSF rotation at the Kansas State University Southwest Research-Extension Center research stations at Garden City and Tribune was initiated in 2014 and at Hays in 2015. Initially, three tillage treatments were compared: 1) single tillage in May or June during fallow, 2) single tillage after wheat harvest, and 3) no-tillage system. Beginning in 2017, two additional treatments were added: 4) single

tillage in fallow plus single tillage after wheat harvest, and 5) two tillage operations during fallow. All treatments are arranged in a split-plot randomized complete block with four replications. The main plot is crop phase (all crop phases present each year), and split-plot was tillage treatment.

A sweep plow (Minimizer by Premier Tillage) was used for all tillage operations. Herbicides were used to control weeds across all treatments. All other cultural practices (variety/hybrid, seeding rate, fertilization, etc.) varied by location but were consistent within a location for all treatments.

## Results and Discussion

Weeds were effectively controlled in all treatments although herbicide resistant kochia and Johnsongrass at Garden City were difficult to control.

At Garden City, treatment differences varied by year, but in most years and across years the tillage during the fallow year increased yield (Table 1). Drought and hail damage resulted in some years of no sorghum yield at Garden City. No treatment differences in grain sorghum yields occurred at Garden City (Table 2).

At Hays, wheat and grain sorghum yields were not affected by treatment (Table 3 and Table 4).

At Tribune, treatment did not affect wheat yield (Table 5). Grain sorghum yield was greatest in no-till and least in the treatment with both tillage in fallow and post-wheat harvest (Table 6).

In other research (Schlegel et al. 2018), reduced tillage systems (with four tillage operations) produced lower yields than no-till in a WSF rotation. Yield differences in this prior study became more apparent after 10 years. Yield differences in the current study may also start to become more apparent with time. With the exception of maybe Tribune, an occasional tillage operation to manage herbicide-resistant weeds appeared to have little effect on crop yield.

## Acknowledgment

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**Table 1. Occasional tillage treatment effect on wheat yields, 2014 through present at Garden City, KS**

| Year | No-till | June tillage in fallow | July after wheat | June and July in fallow | June in fallow and July after wheat | *P* > F |
|---|---|---|---|---|---|---|
| 2014 | 7.3 | 5.7 | 8.0 | --- | --- | --- |
| 2015 | 31.7 | 32.6 | 28.3 | --- | --- | --- |
| 2016 | 51.5 | 55.8 | 52.4 | --- | --- | --- |
| 2017 | 20.0 | 19.5 | 23.0 | --- | --- | --- |
| 2018 | 3.6 | 3.4 | 6.6 | 8.6 | 7.4 | 0.04 |
| 2019 | 89.5 | 100.3 | 83.0 | 95.2 | 100.0 | 0.00 |
| 2020 | 26.9 | 29.0 | 24.3 | 32.1 | 32.4 | 0.01 |
| 2021 | 41.3 | 72.8 | 46.1 | 65.1 | 66.1 | 0.00 |
| 2022 | 22.9 | 30.1 | 17.1 | 26.1 | 28.1 | 0.04 |
| 2023 | 24.2 | 23.4 | 18.4 | 15.3 | 21.8 | 0.01 |
| 2024 | 42.5 | 43.0 | 47.5 | 42.9 | 46.5 | 0.72 |
| Average | | | | | | |
| 2014-present | 32.9 | 37.8 | 32.2 | --- | --- | --- |
| 2018-present | 32.9b | 37.8a | 32.2b | 40.8a | 43.2a | <0.0001 |

Letters different within a row significant at $P \leq 0.05$

**Table 2. Occasional tillage treatment effect on sorghum yields, 2014 through present at Garden City, KS**

| Year | No-till | June tillage in fallow | July after wheat | June and July in fallow | June in fallow and July after wheat | *P* > F |
|---|---|---|---|---|---|---|
| 2014 | 54.3 | 53.4 | 44.1 | --- | --- | --- |
| 2015 | 58.6 | 57.4 | 67.7 | --- | --- | --- |
| 2016 | 108.5 | 112.8 | 65.8 | --- | --- | --- |
| 2017 | 50.6 | 46.4 | 44.1 | --- | --- | --- |
| 2018 | 97.7 | 88.5 | 93.1 | --- | --- | --- |
| 2019 | 40.7 | 40.9 | 39.8 | 41.8 | 37.9 | 0.8 |
| 2020 | 46.8 | 46.3 | 47.2 | 44.4 | 45.0 | 1.0 |
| 2021 | --- | --- | --- | --- | --- | --- |
| 2022 | 10.4 | 10.4 | 3.7 | 11.7 | 7.1 | 0.1 |
| 2023 | --- | --- | --- | --- | --- | --- |
| 2024 | --- | --- | --- | --- | --- | --- |
| Average | | | | | | |
| 2014-present | 58.4 | 57.0 | 50.7 | --- | --- | --- |
| 2019-present | 32.6a | 32.5a | 30.2a | 32.6a | 30.0a | 0.8 |

Letters different within a row significant at $P \leq 0.05$

**Table 3. Occasional tillage treatment effect on wheat yields, 2015 through 2024 at Hays, KS**

| Year | No-till | June tillage in fallow | June and July in fallow | July after wheat | June in fallow and July after wheat | *P* > F |
|---|---|---|---|---|---|---|
| 2015 | 12b | 16.3a | 14.3ab | --- | --- | 0.06 |
| 2016 | 60.3ab | 58.3b | 63.7a | --- | --- | 0.09 |
| 2017 | 35.0a | 43.0a | 33.7a | --- | --- | 0.28 |
| 2018 | 29.0a | 28.3a | 26.7a | --- | --- | 0.79 |
| 2019 | 42.3a | 52.7a | 46.7a | --- | --- | 0.21 |
| 2020 | 57.3a | 62.7a | 58.7a | --- | --- | 0.45 |
| 2021 | --- | --- | --- | --- | --- | --- |
| 2022 | 36.7a | 39.7a | 39.7a | 39.3a | 38.7 | 0.96 |
| 2023 | 14.0a | 12.7a | 16.7a | 18.7a | 21.3a | 0.69 |
| 2024 | 27.3a | 24.3a | 26.0a | 26.7a | 25.3a | 0.82 |
| Average | | | | | | |
| 2022-present | 26.0a | 25.6a | 29.0a | 28.2a | 26.9a | 0.82 |
| 2015-present | 34.9a | 37.6a | 36.6a | --- | --- | 0.96 |

Letters different within a row significant at $P \leq 0.05$

**Table 4. Occasional tillage treatment effect on grain sorghum yields, 2015 through 2024 at Hays, KS**

| Year | No-till | June tillage in fallow | June and July in fallow | July after wheat | June in fallow and July after wheat | *P* > F |
|---|---|---|---|---|---|---|
| 2015 | 102.6a | 85.0b | 90.3ab | --- | --- | 0.07 |
| 2016 | 97.7a | 97.3a | 91.0a | --- | --- | 0.40 |
| 2017 | 92.0a | 80.0a | 95.0a | --- | --- | 0.27 |
| 2018 | 95.3a | 98.0a | 87.7a | --- | --- | 0.21 |
| 2019 | 106.0a | 96.0ab | 92.0b | --- | --- | 0.10 |
| 2020 | 105.7a | 97.0 b | 91.3b | --- | --- | 0.08 |
| 2021 | 73.0 a | 67.3a | 76.0a | 62.3a | 65.0a | 0404 |
| 2022 | 46.7 a | 33.0 a | 34.0 a | 36.0 a | 31.7 a | 0.50 |
| 2023 | 42.3a | 52.3a | 36.3a | 42.0a | 51.7a | 0.21 |
| 2024 | 62.7a | 55.7abc | 51.3bc | 49.0c | 59.0ab | 0.06 |
| Average | | | | | | |
| 2021-present | 56.2a | 50.8a | 49.4a | 48.9a | 51.8a | 0.85 |
| 2015-present | 82.4a | 75.6a | 74.5a | --- | --- | 0.42 |

Letters different within a row significant at $P \leq 0.05$

**Table 5. Occasional tillage effect on wheat grain yields, K-State SWREC-Tribune**

| Year | No-till | June in fallow | July after wheat harvest | June in fallow and July after wheat harvest | June and July in fallow |
|---|---|---|---|---|---|
| 2014 | 28.0 | 22.3 | 23.2 | --- | --- |
| 2015 | 23.7 | 21.7 | 20.6 | --- | --- |
| 2016 | 74.7 | 81.3 | 76.8 | --- | --- |
| 2017 | 30.2 | 24.6 | 26.6 | --- | --- |
| 2018 | 57.3 | 58.0 | 56.8 | --- | --- |
| 2019 | 93.4 | 89.3 | 88.9 | 92.4 | 88.2 |
| 2020 | 45.1 | 40.1 | 42.3 | 40.7 | 40.3 |
| 2021 | 68.8 | 64.5 | 66.6 | 69.5 | 71.4 |
| 2022 | --- | --- | --- | --- | --- |
| 2023 | 16.1 | 21.3 | 25.3 | 30.3 | 22.9 |
| 2024 | 29.2 | 29.5 | 29.8 | 30.1 | 31.6 |
| Average | | | | | |
| 2014-present | 46.7 | 45.3 | 45.7 | --- | --- |
| 2019-present | 50.5a | 48.9a | 50.6a | 52.6a | 50.9a |

Letters different within a row significant at $P \leq 0.05$

**Table 6. Occasional tillage effect on sorghum grain yields, K-State SWREC-Tribune**

| Year | No-till | June in fallow | July after wheat harvest | June in fallow and July after wheat harvest | June and July in fallow |
|---|---|---|---|---|---|
| 2014 | 77.0 | 84.2 | 86.1 | --- | --- |
| 2015 | 132.8 | 113.7 | 107.9 | --- | --- |
| 2016 | 129.4 | 128.6 | 126.5 | --- | --- |
| 2017 | 147.3 | 145.3 | 140.9 | --- | --- |
| 2018 | 130.0 | 123.2 | 114.9 | --- | --- |
| 2019 | 132.0 | 128.7 | 130.7 | 132.0 | 133.3 |
| 2020 | 98.9 | 102.2 | 94.0 | 86.3 | 95.5 |
| 2021 | 120.5 | 109.8 | 115.3 | 115.9 | 120.0 |
| 2022 | 75.0 | 66.0 | 60.9 | 64.0 | 73.9 |
| 2023 | 86.3 | 74.4 | 77.5 | 55.0 | 65.6 |
| 2024 | 99.7 | 77.6 | 72.3 | 45.8 | 71.7 |
| Average | | | | | |
| 2014-present | 111.7a | 104.9b | 102.5b | --- | --- |
| 2019-present | 102.1a | 93.1b | 91.8b | 83.1c | 93.3b |

Letters different within a row significant at $P \leq 0.05$