

Date: Nov 26, 2022

To: "Nicholas Medina" nmedina@umich.edu

From: "Soil & Tillage Research" support@elsevier.com

Subject: Decision on submission to Soil & Tillage Research



Manuscript Number: STILL-D-22-00785

Mixing cover crops suppresses weeds and roto-till improves urban soil compaction and infiltration

Dear Mr. Medina,

Thank you for submitting your manuscript to Soil & Tillage Research.

I have completed my evaluation of your manuscript. **The reviewers recommend reconsideration of your manuscript following major revision. I invite you to resubmit your manuscript after addressing the comments below. Please resubmit your revised manuscript by Jan 25, 2023.**

When revising your manuscript, please consider all issues mentioned in the reviewers' comments carefully: please outline every change made in response to their comments and provide suitable rebuttals for any comments not addressed. Please note that your revised submission may need to be re-reviewed.

To submit your revised manuscript, please log in as an author at <https://www.editorialmanager.com/still/>, and navigate to the "Submissions Needing Revision" folder.

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Soil & Tillage Research values your contribution and I look forward to receiving your revised manuscript.

Kind regards,

Rainer Horn

Editor

Soil & Tillage Research

Editor and Reviewer comments:

Reviewer's Responses to Questions

Note: In order to effectively convey your recommendations for improvement to the author(s), and help editors make well-informed and efficient decisions, we ask you to answer the following specific questions about the manuscript and provide additional suggestions where appropriate.

1. Are the objectives and the rationale of the study clearly stated?

Please provide suggestions to the author(s) on how to improve the clarity of the objectives and rationale of the study. Please number each suggestion so that author(s) can more easily respond.

Reviewer #1: This study was conducted to examine effect of different tillage methods and cover crop mixes on soil compaction, water infiltration rate, weed pressure, and crop yield. Undoubtedly, improving the physical properties of the soil is of great importance in terms of maintaining soil fertility. For this reason, the subject of the study is essential for the protection of agricultural lands. It is a scientific and innovative article especially urban agriculture. In the presented article, the aims and justification of the study are clearly stated.

Reviewer #2: Please see comments below

Reviewer #3: THe rationale of the study is clearly stated in the introduction

We thank reviewer acknowledgement of this article's scientific rigor and novelty.

2. If applicable, is the application/theory/method/study reported in sufficient detail to allow for its replicability and/or reproducibility?

Please provide suggestions to the author(s) on how to improve the replicability/reproducibility of their study. Please number each suggestion so that the author(s) can more easily respond.

Reviewer #1: Mark as appropriate with an X:

Yes ☐ No ☒ N/A ☐

Provide further comments here:

Some of my suggestions and corrections regarding the article are presented below.

1. The abstract should state briefly the purpose of the research, the principal results and major conclusions. There is no numerical data on the results of the research in the abstract section. Important numerical values should be added to this section.

The following numerical results were added to the Abstract:

"Results showed that both roto- and tractor-till significantly lowered soil strength compaction by ~50% overall but not yield when compared to no-till, and roto-till also improved infiltration by ~15%, while tractor-till reached deeper soils but allowed ~7% denser weed growth. Mixing sorghum-sudangrass, buckwheat, and cowpea cover crops significantly reduced weed density by ~50% compared to other mixtures, and perennials appeared to increase depth to hardpan by 2.5 cm (~17%) but not affect soil water infiltration under no-till."

2. There is no detailed information about the tillage tools used in the study, . What is broadfork? How were plant seeds sown? Is the seed drill used or not? No information.

Information about tillage tools were added to the relevant (second) paragraph in the Design sub-section of Methods section:

"...treatments included no-till with a manual long-tined broadfork (NT) tool used for gardens and small farms, roto-tiller (RT)..."

"...tractor (New Holland 7308) up to 30.5 cm (1 ft) deep. Roto-till plots were treated with a roto-tiller (BCS 749) implement..."

Seed planting information was placed in the relevant (third) paragraph of the same Design sub-section of the Methods section:

"Crops were planted using a manual rolling seeder up to 30 cm between rows and seeds pressed 1-2.5 cm deep based on cover crop."

Reviewer #2: Mark as appropriate with an X:

Yes ☒ No ☐ N/A ☐

Provide further comments here: Please see comments below

Reviewer #3: Mark as appropriate with an X:

Yes ☒ No ☐ N/A ☐

Provide further comments here: Mention the soil moisture when doing penetrometer measurements

We added wording considering the potential effects of soil moisture in explaining treatment effects in this case as a response to optional comment field B below.

4. Could the manuscript benefit from additional tables or figures, or from improving or removing (some of the) existing ones?

Please provide specific suggestions for improvements, removals, or additions of figures or tables. Please number each suggestion so that author(s) can more easily respond.

Reviewer #1: The tables or figures in the manuscript are usefull.

Reviewer #2: Please see comments below

Reviewer #3: See my recommendations

We thank reviewer acknowledgement that article figures and tables are useful.

6. Have the authors clearly emphasized the strengths of their study/theory/methods/argument?

Please provide suggestions to the author(s) on how to better emphasize the strengths of their study. Please number each suggestion so that the author(s) can more easily respond.

Reviewer #1: The authors have clearly emphasized the strengths of their study/theory/methods/argument.

The effect of agricultural tools and machineries on the physical properties of the soil should be observed for at least 2 or 3 years. The topic chosen is important. But, one-year data does not enable for sufficient scientific results.

We acknowledge that more data would further support conclusions. However, this study shows that urban soils certainly can respond significantly to treatment even after one year. This serves as exciting support for the use of cover crop polyculture mixes as a form of sustainable agriculture to reverse otherwise degraded urban soils.

Accordingly, we maintain that this article presenting significant results from a first year of agricultural management is scientific and innovative, as reviewed above, meriting acceptance for publication in *Soil & Till Res.*

Reviewer #2: Please see comments below

Reviewer #3: The authors have emphasized enough the strength of their study

We thank both reviewers' acknowledgement of the strengths of this study.

7. Have the authors clearly stated the limitations of their study/theory/methods/argument?

Please list the limitations that the author(s) need to add or emphasize.
Please number each limitation so that author(s) can more easily respond.

Reviewer #1: The authors have not clearly stated the limitations of their study/theory/methods/argument.

1. There is no detailed information about the tillage tools used in the study, .

This information was added to the Methods section as described above in response to previous reviewer comment.

2. What is broadfork?

This definition was added to the Methods section, in the tillage tools description, as described above in response to previous reviewer comment.

3. How were plant seeds sown? Is the seed drill used or not? No information.

This detail was added to the Methods section, ending the (third) cover crops paragraph, as described above in response to previous reviewer comment.

Reviewer #2: Please see comments below

Reviewer #3: Yes they suggest further research

We thank reviewer acknowledgement that we suggest further research in the article.

8. Does the manuscript structure, flow or writing need improving (e.g., the addition of subheadings, shortening of text, reorganization of sections, or moving details from one section to another)?

Please provide suggestions to the author(s) on how to improve the manuscript structure and flow. Please number each suggestion so that author(s) can more easily respond.

Reviewer #1: Material and Abstract section should be rearranged.

The Abstract and Methods sections were updated according to the specific review suggestions made above and below this review comment.

There is no detailed information about the tillage tools used in the study, .

This information was added to the Methods section as described above in response to previous reviewer comment.

2. What is broadfork?

This definition was added to the Methods section, in the tillage tools description, as described above in response to previous reviewer comment.

3. How were plant seeds sown? Is the seed drill used or not? No information.

This information was added to the Methods section in response to Question 7 comments above.

Reviewer #2: Please see comments below

Reviewer #3: The structure is appropriate

We thank reviewer acknowledgement of the appropriate structure of this manuscript.

9. Could the manuscript benefit from language editing?

Reviewer #1: No

Reviewer #2: No

Reviewer #3: No

We thank reviewer acknowledgement of this article's clear language use.

OPTIONAL FIELDS/COMMENTS

Reviewer #1: This field is optional. If you have any additional suggestions beyond those relevant to the questions above, please number and list them here.

We thank Reviewer 1 for concise comments above.

Reviewer #2: This field is optional. If you have any additional suggestions beyond those relevant to the questions above, please number and list them here.

The authors evaluated how tillage methods representing various intensities and cover crop mixes affect soil penetration resistance and water infiltration rate. The paper falls within the scope of Soil and Tillage Research. I am concerned about the following shortcomings:

A. The "compaction" as measured by penetrometer is used in the title and widely in the text to characterize soil compaction level. Commonly penetration resistance with a cone penetrometer is used as a component of soil strength and bulk density as an indicator of compactness. It is necessary throughout the paper to distinguish carefully between these properties. "Soil compaction" is defined as an increase in bulk density and a decrease in soil porosity resulting from e.g. applied loads, vibration, or pressure.

We thank the reviewer for bringing up this distinction affecting interpretive discussion of field measurements. We note that in the field, soil strength does often correlate positively with soil density (Han et al 2009 Can J For Res), and similarly, can reasonably reflect underlying issues with soil compaction, especially likely in engineered urban Technosols. Accordingly, soil strength can be an accurate indicator of practical compaction issues affecting potential crop rooting extents in urban soils.

Although to more precisely align with our field penetrometer measurements, we have accepted this reviewer suggestion and indeed replaced most instances discussing "soil compaction" to "soil strength" throughout all sections of the article, including in the title, while leaving a few cases out where mentioning "compaction-related issues" was reasonably relevant to broader implications.

We have also focused on the phrase "depth to hardpan" as the direct measure presented for the Results section.

To present a few more specifically, to the relevant (second) paragraph in the Introduction, we added the following as an early second sentence:

“...short term, tilling can improve soil porosity to alleviate compaction issues by lowering soil bulk density and soil strength (i.e. resistance to shearing) enough to deepen the depth to harder soil layers that are impenetrable by roots (i.e. hardpan; resistance >2 MPa) (Badalíková, 2010; Hill et al., 1985). Short-term tilling can also improve nutrient ...”

To the relevant (first) paragraph in the Sampling sub-section of the Methods section, we clarified the terminology of what we measured:

“Soil compaction-related issues were measured as soil strength (resistance to shear), read as the depth to hardpan layer, or where soil strength was >2 MPa, beyond which roots typically cannot penetrate (Correa et al., 2019). Soil strength often correlates positively with soil compaction when measured as higher soil density (Han et al 2009), and is also likely in engineered Technosols. Furthermore, depth to soil hardpan serves as a measure of potential rooting extent, making it a relevant indicator of common compaction-related issues affecting urban agricultural potential. ...”

Other example changes extend to occasional phrasings in the Discussion section that were clarified.

B. Soil penetrometer resistance is a result of not only soil compaction but also soil water content, which is not reported in the paper (L 191-194).
Missing soil water content data does not allow evaluation of whether a given penetrometer resistance is influenced by soil compaction or water content or both. This should be clarified to indicate the effects of the study treatments. Provide basic information about measurements of penetration resistance (e.g. cone diameter, cone angle)

The information about cone diameter and tip angle was added to these lines.

To analyze how treatment affects might be potentially mediated by soil moisture, we added this sentence to the beginning of the relevant (second) paragraph in the Discussion section:

“... tillage method intensity corresponds negatively with depth to hardpan. This can be due to changes in either soil density or remnant moisture at depth, but given that infiltration results did not mirror soil strength results, it may be more likely that changes to soil density, either from textural or structural (arrangement) changes, is the larger underlying cause compared to consistent soil moisture differences.”

C. Compaction data (Figure 2) and text: "compaction" in upper part of the Fig. 2 refers to the mix of Forage Radish Crimson Clover Cereal Ryegrass that is specifically designed to alleviate compaction level by loosening the soil (Table 2, L 177-180). In other places "compaction" is used as an indicator of soil compactness (e.g. L 248,303). Applied terminology and related meaning should be clarified.

In many cases, “compaction” was replaced with “soil strength”, as mentioned previously in optional comment field A, which should clarify this redundancy. In other cases, “compaction” was changed to “compaction-related issues” to be broader in scope of discussion. As it no longer appeared absolutely necessary to clarify this distinction, the name of the cover crop mix treatment remained unchanged (abbreviated in figures, etc.).

Other comments

1. Abstract, L 31-32 and 34: please indicate how soil compaction level was affected.

To do this and clarify results, in both sentences located here, "...affected compaction" was changed to "lowered soil strength...", communicating a direction of change.

2. Introduction L 50-56: the sentence "Single..." is too long. Suggest split it into smaller sentences.

To do this and improve this sentence, it was split into two – "...magnesium, which overall..." was changed to "magnesium. These tradeoffs of single management strategies in turn...", plus a few more minor changes to it.

3. Results, L 242-253: significantly different depths to hard pan (based on critical penetration resistance 2 MPa) in tractor-till and no-till plots is compared without consideration of soil water content that can be different. This should be explained.

We added wording considering the potential effects of soil moisture in explaining treatment effects in this case as a response to optional comment field B above.

3. L 255: define the meaning "H".

To add this definition, the sentence here was changed to "...estimated with η^2 , a measure of the proportion of variance in the dependent variable explained by the independent variable using the test statistic and group replication values, (Tomczak and Tomczak, 2014), and furthermore raw median differences were estimated at finer pairwise levels."

Overall evaluation: for the reasons stated above, the manuscript needs thorough revision.

Reviewer #3: This study compared three different tillage methods (hand tillage with a broadfork, roto-tillage and conventional tillage with moldboard ploughing) combined with three different crop mixes through their effect on soil compaction, infiltration, radish yield and weed pressure. The study was conducted on a site at Michigan state University, on a degraded urban soil. The main result are the positive effect of roto-tillage and tractor tillage on compaction, of roto tillage on infiltration and the efficiency of the cover crops to control weeds, especially of the mix that was designed for this purpose.

General comments

In this paper, compaction was assessed using a penetrometer, and was measured as the depth where resistance is 2 MPa, on dry days. Even if this threshold is considered as a hardpan that roots cannot penetrate, it is important to mention what is the soil moisture profile when the measurements are made... Mentioning that the measurement is made "on dry days" is not sufficient. Especially if the infiltration rate is different between tillage systems, one can imagine that the soil moisture (and therefore its resistance) is not the same between treatments... which distorts the comparison.

We added wording considering the potential effects of soil moisture in explaining treatment effects in this case as a response to optional comment field B above.

Furthermore, in the tilled treatments, I do not understand why the hardpan is often localized at a depth which is lower than the tillage depth... For instance (Fig 2a) the hardpan is localized around 20 cm depth in the tractor tilled treatments while the tillage is supposed to have been done at a depth of 30 cm. This point should be discussed in the paper.

This is a notable point, and we have addressed this by adding a sentence in the appropriate Discussion paragraph around line 307:

"It was notable that under tractor-till, the soil hardpan was detected at a shallower depth than that where the initial treatment was done, suggesting soil particle resettlement, which may occur by redistributing and separating macroaggregates into microaggregate fractions (Zheng et al 2018)."

The paper is well written, the demonstration is clear and the discussion is supported by the results. However, through the whole article, the dimensions are systematically given in the international system unit and in the American system. I suggest to remove the mentions of the American unit system, because this makes the text difficult to read.

We thank reviewer comment that this paper is well-written, the demonstration is clear, and that the discussion is supported by the results.

All American units have been removed for clarity, but leaving a few cases where the American value was a simple integer, which is less distracting.

The illustrations could be improved. There is too many information given in figure 1. I suggest to keep only the plan of the plot layout design. On figures 2, 3 and 4 the results of the statistical comparisons are hardly visible. Especially for $p < 0.1$ or $p > 0.1$. Please change the symbol used and enlarge them on the figure. In the legend what do you mean by "... and may be small"? For me this precision is useless. Very often, you use the expression "marginally significant". I do not agree with this: the difference is significant or is not significant. You have to give the p threshold you retain in the method section of the paper.

Figure 1 was split into two figures, where Figure 2 now contains an enlarged plot layout design (former Figure 1d) as 2a, alongside the aerial view of cover crops growing (former Figure 1e) as 2b.

Significance symbols were changed and sizes enlarged in all figures.

The "...and may be small" refers to error bars that exist but appear smaller than the central black dot size in treatment categories on figures, which cannot be both made smaller and kept reasonably visible. This is in response to alternative comments that treatment central tendency dots should always show error bars when $n > 1$.

We have explicitly included the threshold for significance toward the end of the Statistics sub-section (last) paragraph.

We have maintained the use of significant and marginally significant to align with both convention as well as decreasing reliance on strict p-values cutoffs for hypothesis testing, as stated in the relevant new sentence:

"...treatment effects were delineated at $\alpha = 0.05$, and marginal significance at $0.05 < \alpha < 0.1$ to align with both convention and decreasing emphasis on strict cutoffs for hypothesis testing (Curran-Everett 2020). Treatment..."

Therefore I suggest to accept the paper after some revisions of the text.

Specific comments

Abstract.

Please mention in the abstract the location of the experimental site and the type of soil.

This location and soil information was added near L30 as

"...and crop yield in an urban Technosol in Detroit, MI, USA.

Line 36: replace the term "initial management" by something more explicit.

This phrasing was changed to:

"...balanced trade-offs for lowering soil strength, promoting infiltration, and feasibly minimizing weeds, ..."

Introduction

Lines 47-48: what do you mean by "can increase potential responses to intervention"? Which responses? Please be more explicit.

This sentence was clarified to:

"...saturation (Stewart et al., 2007), they potentially increase in fertility more quickly in response to active sustainable management compared to high-fertility soils (Kumar..."

Lines 76-78: the mention of the dust bowl or the "fall of ancient civilizations" is excessive in the context of this paper...

This example was removed and this statement toned down to the following phrase:

"...dependency on intense tillage to maintain previous yields (de Cárcer et al., 2019), which may risk amplifying local soil fertility issues (Amundson..."

Lines 102-105: the sentence is not clear enough.

This sentence was re-written for clarity to:

"Furthermore, cover crops may benefit even organic large industrial farms, but their dependence on mechanization, such as for harvest, tends to limit their cover crop use to monoculture designs, where as mixed polyculture cover crop designs may be more feasible to adopt in smaller scale urban agriculture settings, where manual labor tasks by growers may be more flexible."

Line 156-157: the stability is very low. But is there a slope on the site that can lead to erosion?

There are minimal slope effects at this site, so this following phrasing was added around line 157 at the end of the first paragraph in the Methods section:

"...crusting when dry, and some erosion and runoff, given slopes of 0-4% (Table 1)."

Lines 170-171: choose between roto-tiller and rototiller

A hyphen "-" was added to the spelling here, to maintain consistency throughout the article.

Table 2: the third column is not necessary

This third column is now removed in the clean article version.

Methods

Lines 145-146: please mention the soil texture in table 1.

The soil textural class designation "Fine" from the Cornell soil health assessment was added as a row in this Table 1 in the physical category.

The soil texture description from Cornell and SSURGO information was added to the sentence at these line numbers, "consistent clay of ~37% and a sandy clay loam texture."

Line 147-149: give the values in cm first.

The order of these measurement units was reversed.

Line 195: using a 16;5 cm cylinder

Thank you, the “cm” units were added here.

Results

Lines 250-253: The sentence is not clear enough. Please rewrite.

To clarify, this sentence was split up into 2, separating overall effect and effect sizes:

“...weed suppression mixes ($p_{adj} = <0.01$). Specifically, the perennial mix raised the depth to hardpan by ~ 2.5 cm (1 in, or $\sim 16.7\%$) compared to other mixes, up to...”.

Figure 2: The difference of size between the y axis of 2a and 2b distorts the comparison.

The panels were re-arranged horizontally and panel 2b y axis enlarged to make observed point ranges comparable across panels in both 2a and 2b.

Lines 283-284: The differences between yields are not significant. However, the variability of the yields is very different between treatments (Fig 5c, regarding the mass of roots harvested in the roto tilled treatment). Please could you comment this?

The following sentence was added to the relevant Results section:

“Notably, radish yield under roto-till tended to be lower compared to other treatments, and also appeared more variable in mass.”

And was elaborated on in the second sentence of the relevant penultimate Discussion paragraph:

“In this study radish yield appeared to be lower and more variable under roto-till, which could be explained in part by leaching of otherwise available nutrients due to observed faster infiltration under roto-till. Furthermore, As ...”

Discussion

Line 290: please give the unit

The effect size unit “cm” was added to this line.

Line 291: yes, but the pan is deeper without cover crop. Please comment this result also.

After the sentence that ends at this line number, the following sentence was added to comment on this result:

“... Fig 2b). It was notable that native vegetation under no-till also showed the deepest depth to hardpan, in part supporting a fallow approach instead of cover crops, but using cover crops may have additional benefits like improving nutrient retention (Tonitto et al 2006). Additionally...”

Lines 315-320: The text is not clear enough there. Please rewrite.

This sentence was changed to:

"This shallower depth to hardpan may be due to dense root mats that can form under grasses (Douglas et al., 1992), such as like sorghum-sudangrass, which could collectively act as a barrier to water flow, especially in otherwise dense soils further fill already limited pore space in densely-structured clay soils, helping water to pool under the soil surface (Hoogmoed and Bouma, 1980). Other studies have generally found similar results (Ozpinar and Cay, 2006) that , suggesting short-term benefits of tillage to soil functions, while acknowledging tradeoffs with long-term costs of tillage (Ozpinar and Cay, 2006)."

Line 328: which, compared to macropores, please add commas

These commas were added at this line number, so that the sentence phrase reads

"...macro-porosity, which, compared to micro-pores, bind water..."

Lines 334-335: "diluting compost benefits to infiltration". Please explain this effect.

To clarify this point, this sentence was changed to

"...explained by compost incorporation, where tractor-till similarly incorporated the same amount of compost more diffusely throughout the soil profile, and thereby diluting potential benefits of compost on water infiltration, such as by improving seasonal soil aggregation (Bach et al 2019)."

Lines 335-343 : this part of the text should be in conclusion.

This text was moved to the middle (starting as sentence #2) of the conclusion paragraph.

Line 351: "in looser soils with various microbes": please explain this...

To clarify this explanation, this sentence phrase was changed to

"...histories, which can allow them to grow denser root systems in more porous soils, despite experiencing variable soil microbiomes nearby...".

Line 347: please check the spelling of Barberi (Bàrberi?)

We now added the vowel character to the spelling of this name Bàrberi.

More information and support

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