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Agriculture

# CONSERVATION TILLAGE PRACTICES FOR POTATO PRODUCTION AND THE ASSOCIATED BACTERIAL AND FUNGAL COMMUNITY ANALYSIS SPANNING THREE PRODUCTION CYCLES

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WORLD POTATO CONGRESS

# Introduction

**Conservation Agriculture** is a way of farming that **combines** the best-known **traditional** and **modern practices** to manage the **natural capital** of agriculture, namely **soil**, **soil organic matter**, **water** and **biodiversity** simultaneously.

**Conservation farming practices for potato production in the Sandveld region of South Africa**

# Main Objective

## From

## To

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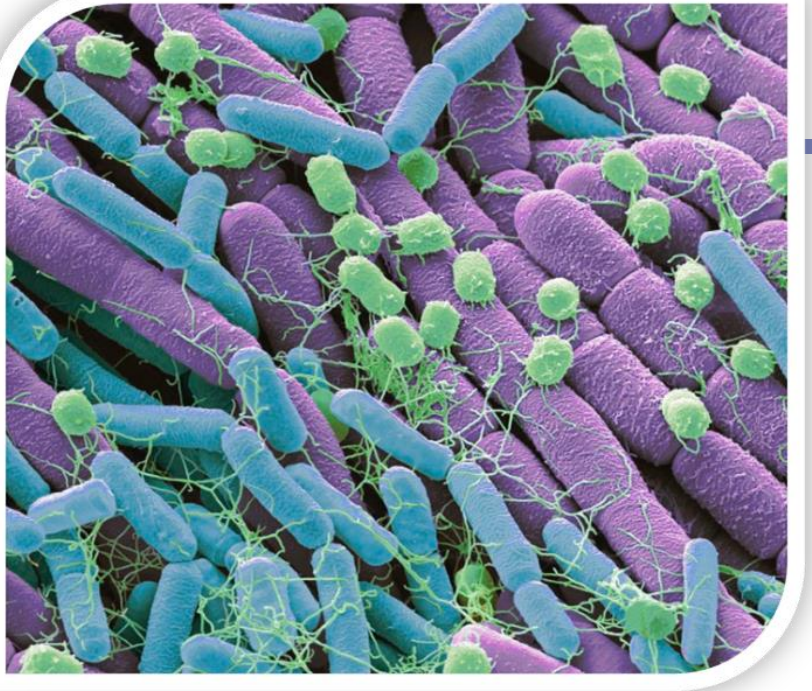
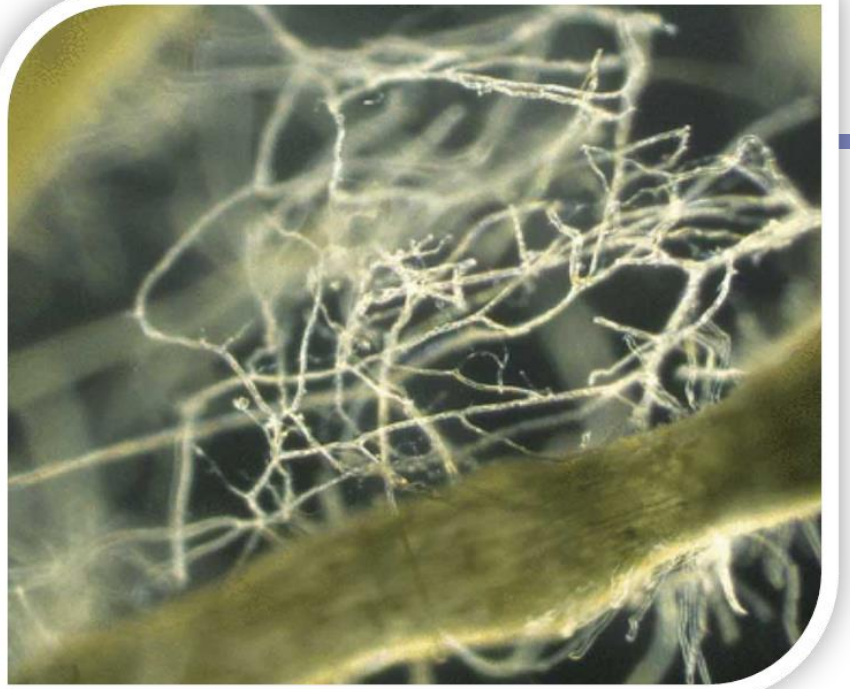
# Bacteria



Bacteria are the most abundant microbes in the soil
Single celled organisms
Billions of bacteria in a single gram of soil
Populations of bacteria can change in few days
Some bacteria species are very fragile  whereas others are extremely tough
Some bacteria are dependent on specific plant species

Bacteria breaks down organic residues in the soil
Bacteria, such as **Rhizobium**, *convert atmospheric nitrogen* into a form that plants can use - **Nitrogen fixation**
Bacteria like **Nitrosomonas** and **Nitrobacter** *convert ammonia* into nitrite and then to nitrate - **Nitrification**
Bacteria like **Pseudomonas** and **Clostridium** *convert nitrate* back into nitrogen gas - **Denitrification**
Some bacteria produce **antibiotics** that **protect** plants from disease-causing organisms
Bacteria help form stable aggregates in the soil

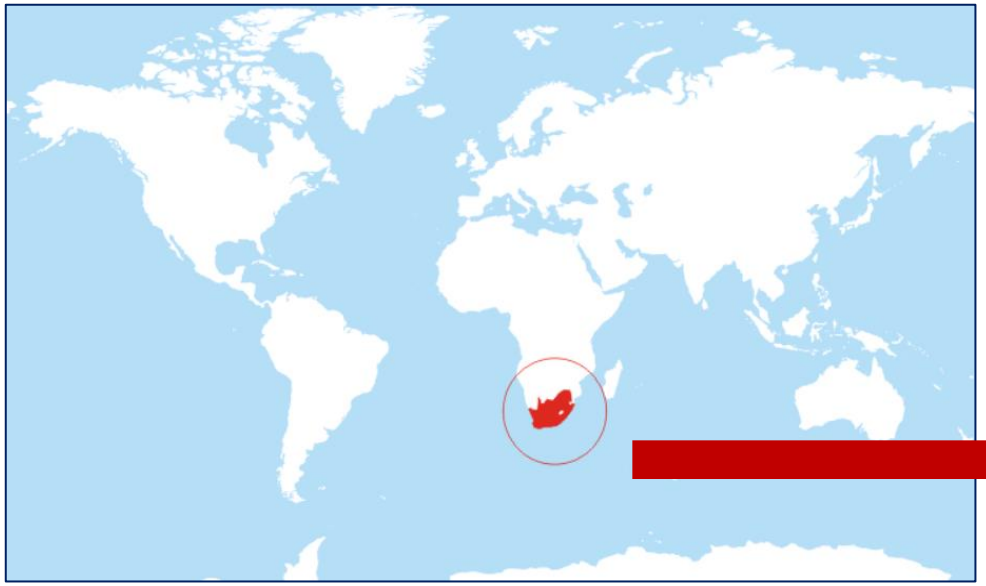
# Fungi



Soil fungi are microscopic plant-like cells
Single celled (e.g. yeast)
Long threadlike structures or hyphae that make a mass called mycelium
Can be symbiotic with plant roots
Not as dependent on specific plant species as some bacteria
Populations are slower to develop

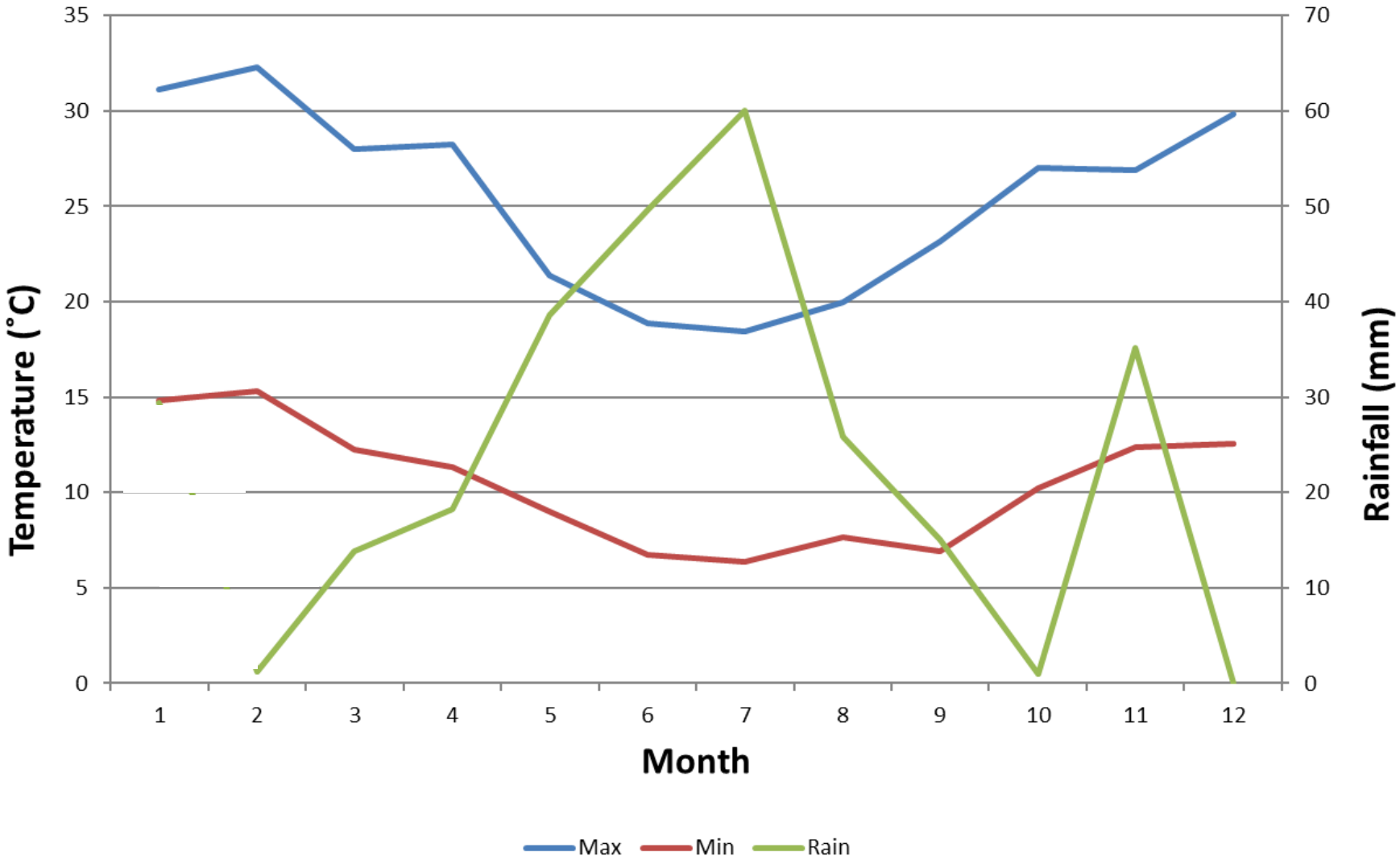
Most soil fungi *decompose* organic matter
Play a crucial role in *recycling nutrients*
Form symbiotic relationships with plants – **mycorrhizae**
Aggregate soil particles - **hyphae**
Some suppress plant diseases
Improve plant nutrient uptake, especially in stressed conditions
Transport water from the soil to the plant
Contribute to soil **carbon sequestration**

# Materials and Methods:Location

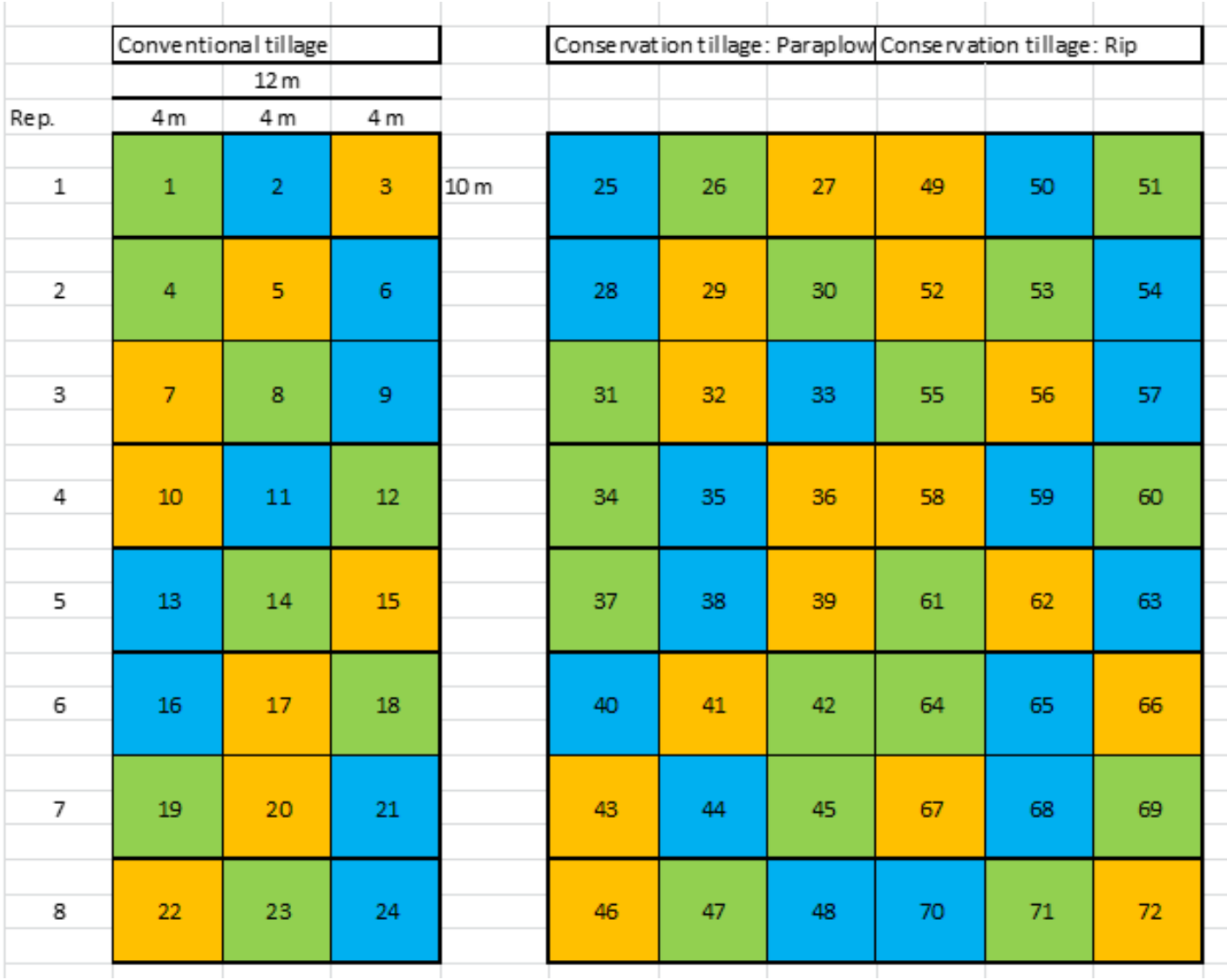





# Climate - Aurora



# Materials and Methods:
## Trial layout- Randomised complete block with 3 experimental units



# Materials and Methods: Tillage

## Conventional tillage: Mouldboard

Irrigate up to field water capacity (FWC) before tilling

Mouldboard plough up to a depth of **350 mm**

Level with a ghrop and broadcast fertiliser

Rip **600 mm** deep between planting rows

Plant potatoes

Rip **600 mm** deep after plant in tyre tracks


## Conservation tillage: Rip

Irrigate up to FWC before tilling

Broadcast fertiliser + scarify

Rip **600 mm** deep in planting rows

Plant potatoes

Rip **600 mm** deep after plant between rows

## Conservation tillage: Paraplough

Irrigate up to FWC before tilling

Broadcast fertiliser + scarify

Plant potatoes

Paraplough **600 mm** deep over two planting rows

# Materials and Methods: Microbial community analysis

**Fluorescently labelled primers -** amplified the Internal transcribed spacer (ITS) regions

**Determined the community structure** by using Automated Ribosomal Intergenic Spacer Analysis (ARISA)

**The amplicons of the samples were run** on an ABI 3010XL Genetic analyser to obtain electropherograms

**The ARISA PCR samples were run** with the LIZ1200 size standard

**Genemapper 5 software** converted the fluorescent data to peaks of different fragment lengths

These peaks of different fragment lengths are termed **operational taxonomic units (OTUs)**

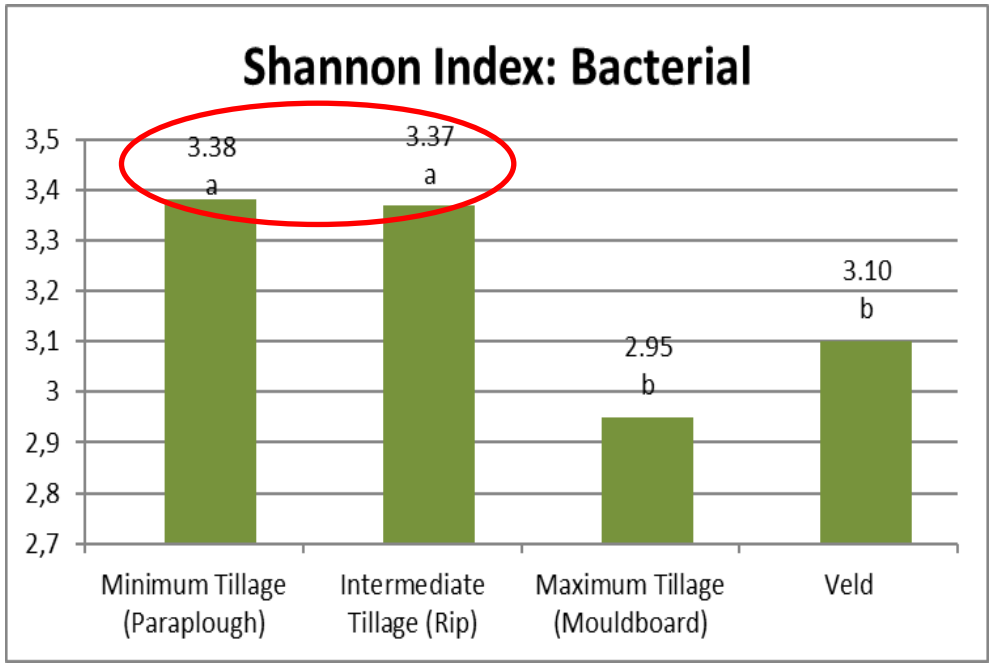
**Peak heights** are used to indicate the **relative abundance** of the fragments in the samples

**Only fragment sizes between 100 and 1000 base pairs and peak heights above 150 fluorescent units** were used for analysis as OTUs

**A bin size of 3 bp** was used to minimize inaccuracies of the ARISA profile
**(Brown et al., 2005; Slabbert et al., 2010)**

All **alpha** (Shannon and Simpsons) and **beta diversity** (NMDS graphs) calculations, and statistical analyses were performed **using the 'microeco'** (Liu et al. 2021) **and 'vegan' packages** (Oksanen et al. 2020)

# Bacterial Community Analysis




**Shannon index**

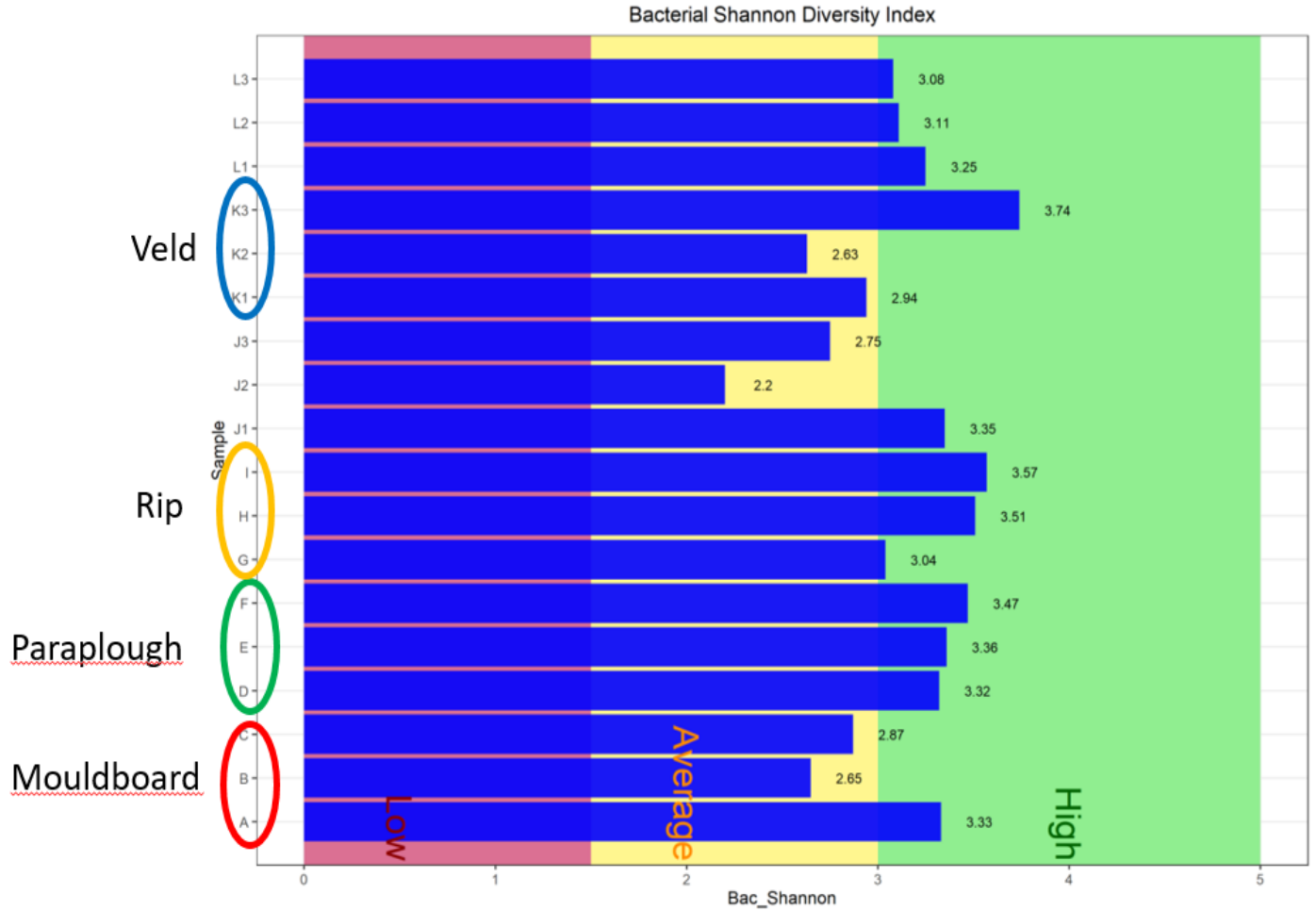
This index is used to observe the richness and evenness of the microbial community within a sample.

Values typically lie between 1.5 and 3.5, but can reach above 4 in rare occassions.

It is calculated by looking at the number of different species and their abundance.

*A high Shannon index indicates that the microbial community is even.*

*A low value indicates that there is a dominating effect happening within the sample.*

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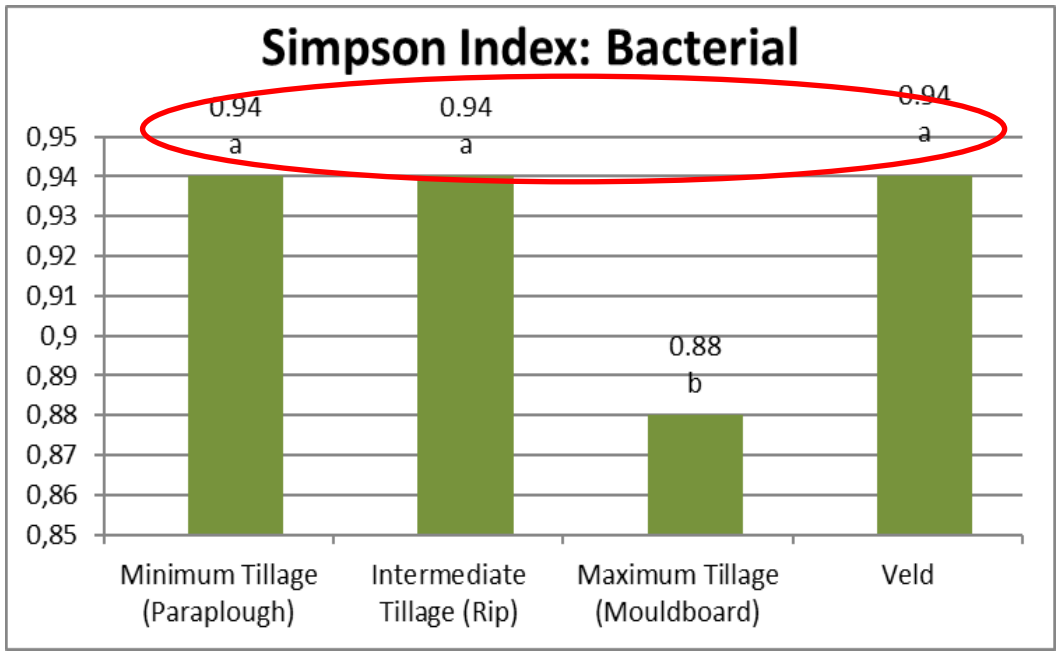


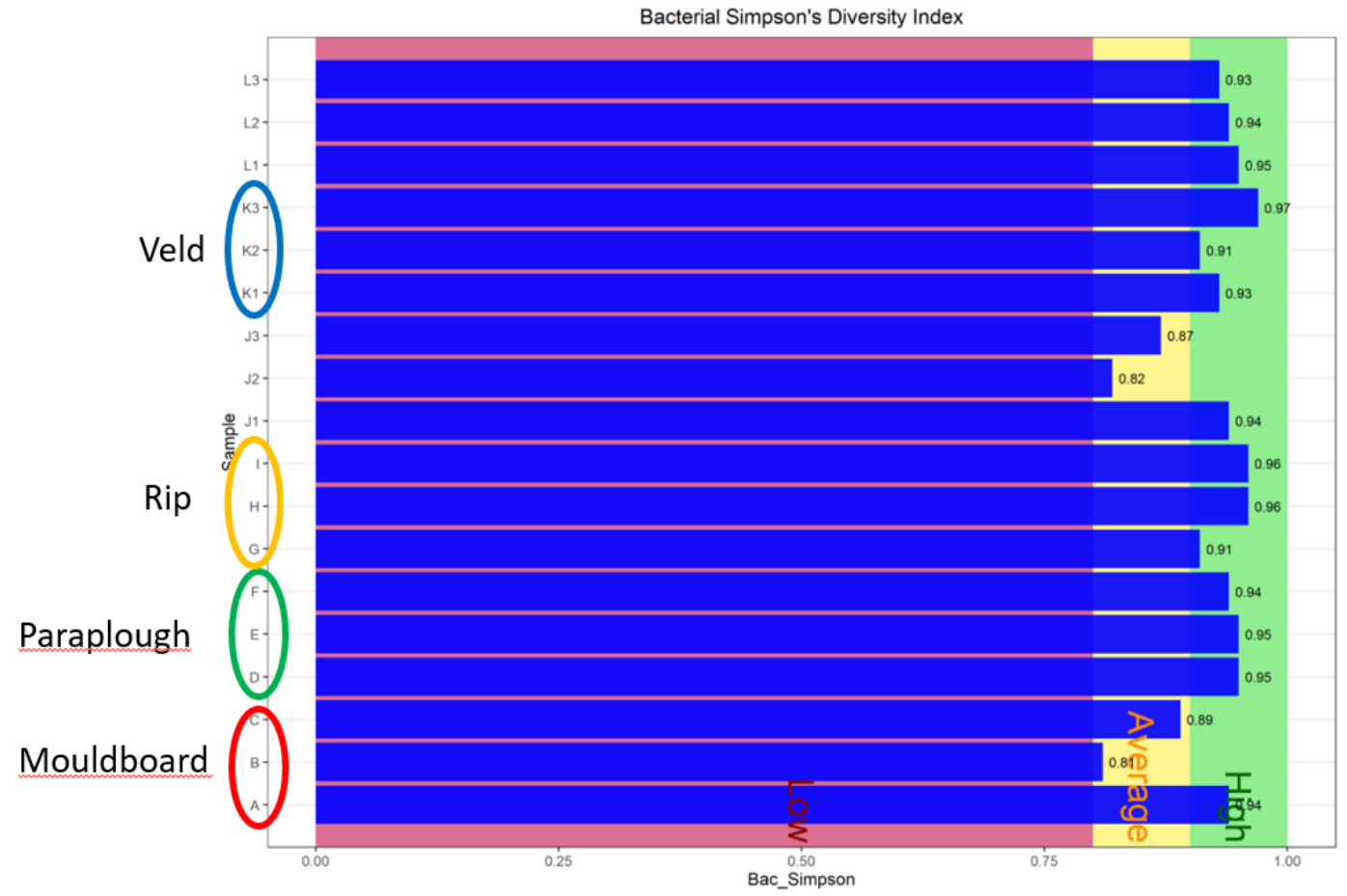

**Simpson's index**

This index is used along with the Shannon index to describe the microbial evenness within a sample.

These values will always fall between 0 and 1.

*A value close to 1 indicates low dominance.*

*A value of 0 indicates that the microbial community within the sample is dominated by one, or very few, microorganisms.*



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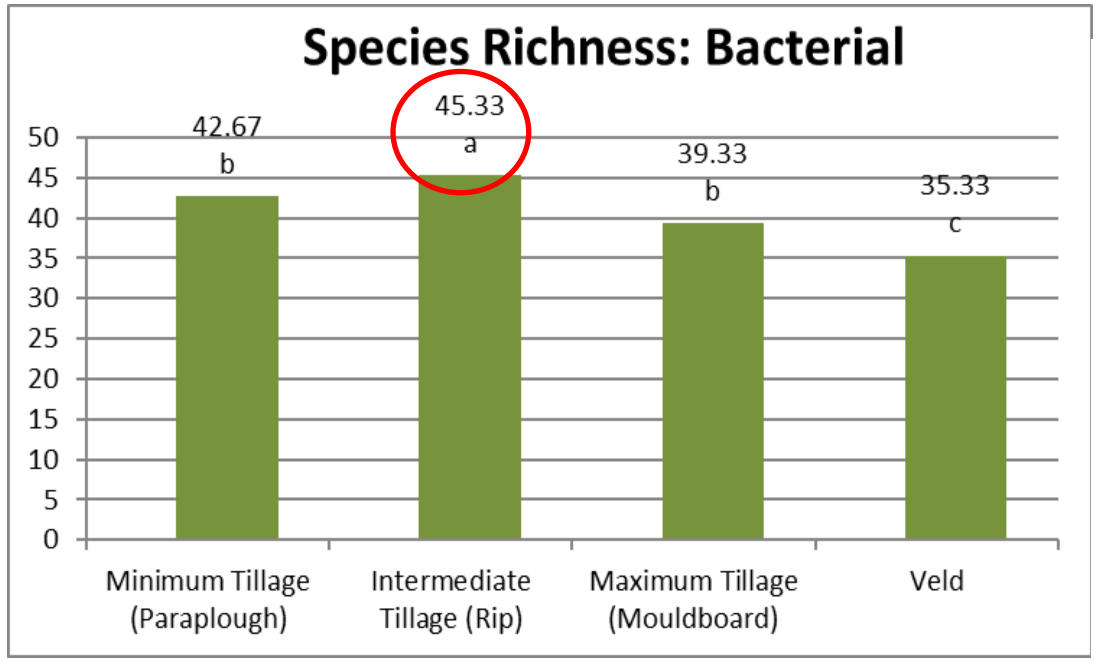
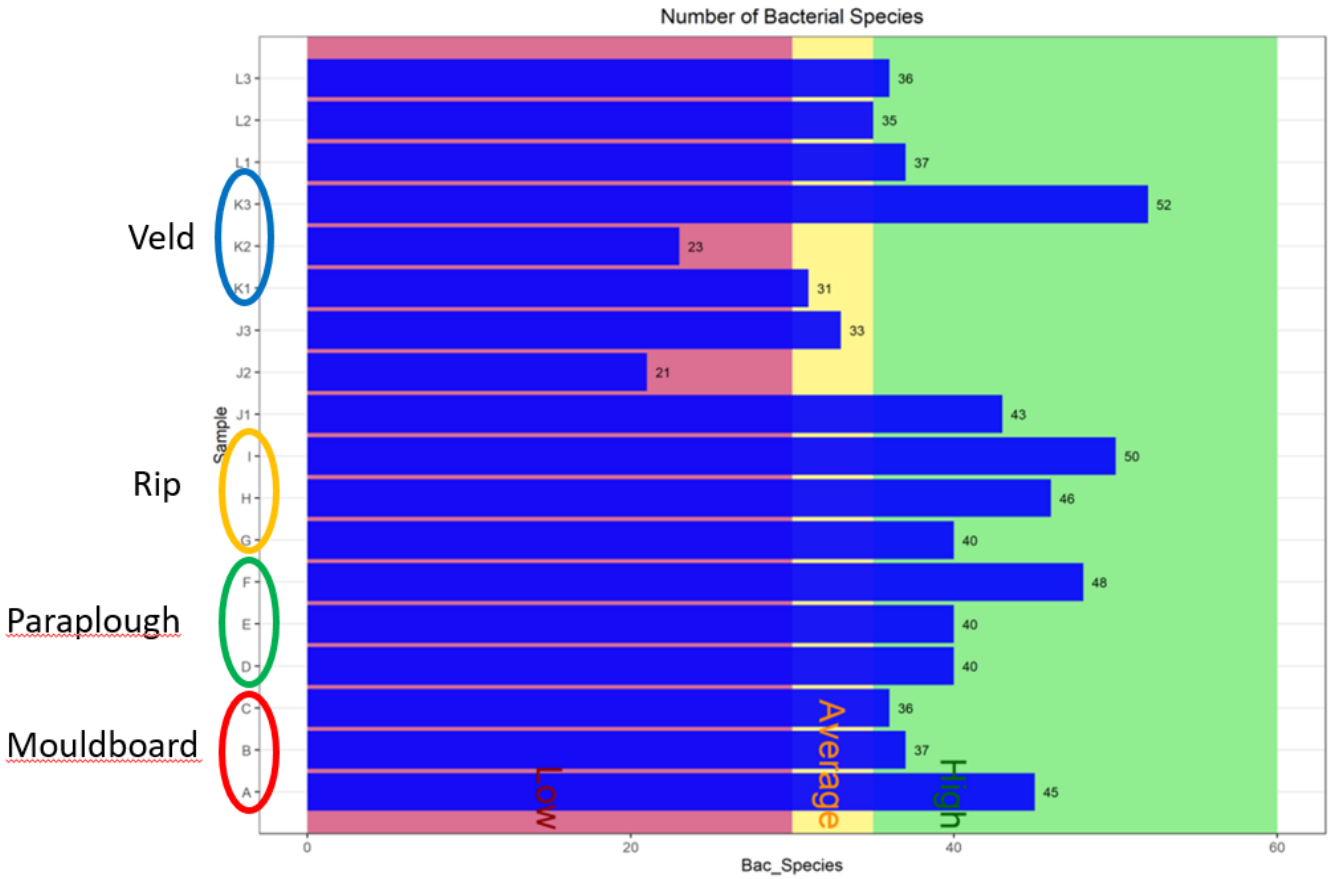



**Species richness**

This value shows the number of Operational Taxonomic Units (OTUs).

*A higher OTU value indicates a high level of diversity, but it should be uniquely interpreted for every case as the environment determines what the highest diversity limit could be.*



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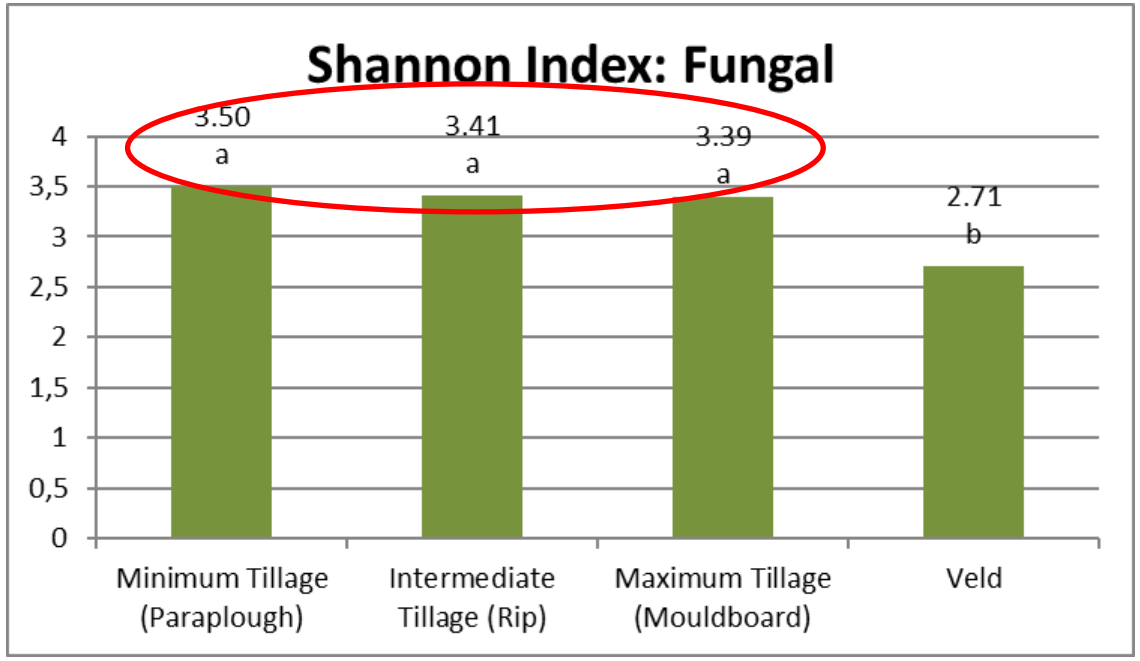


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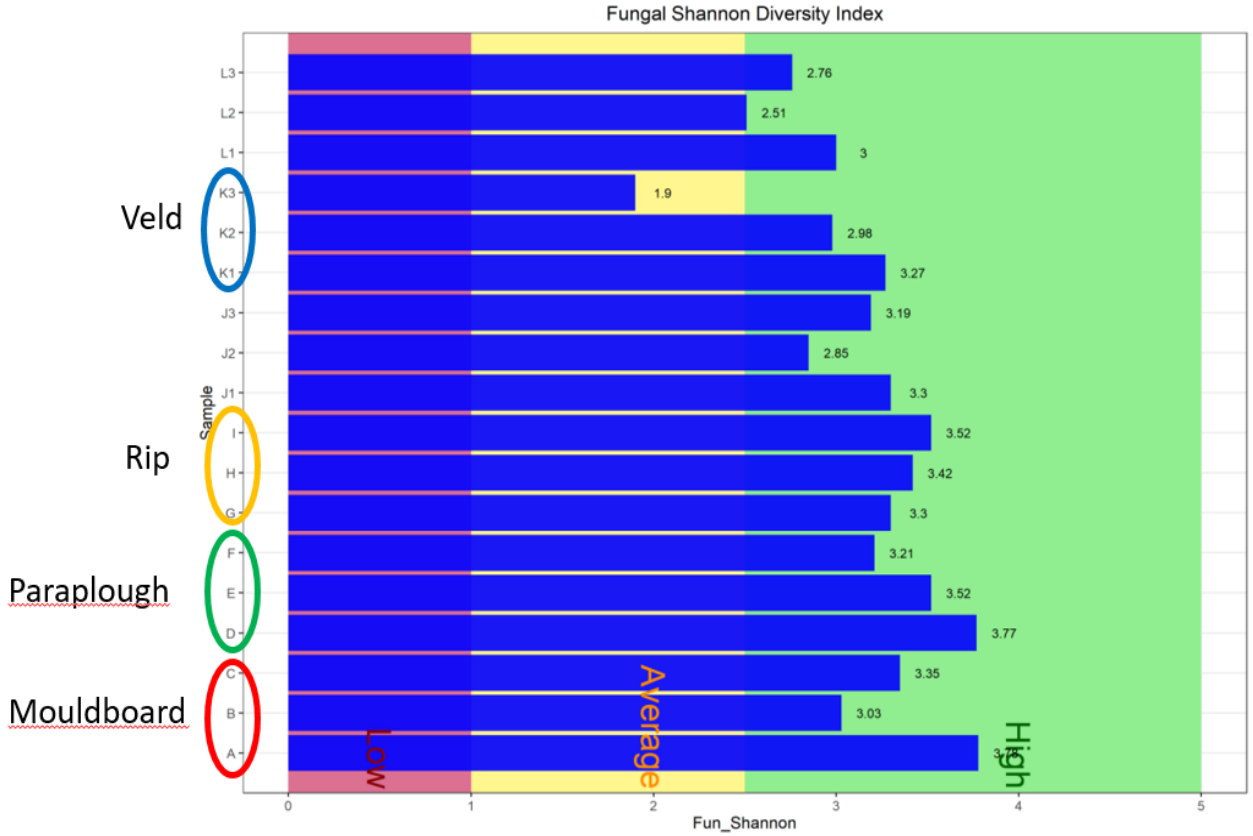


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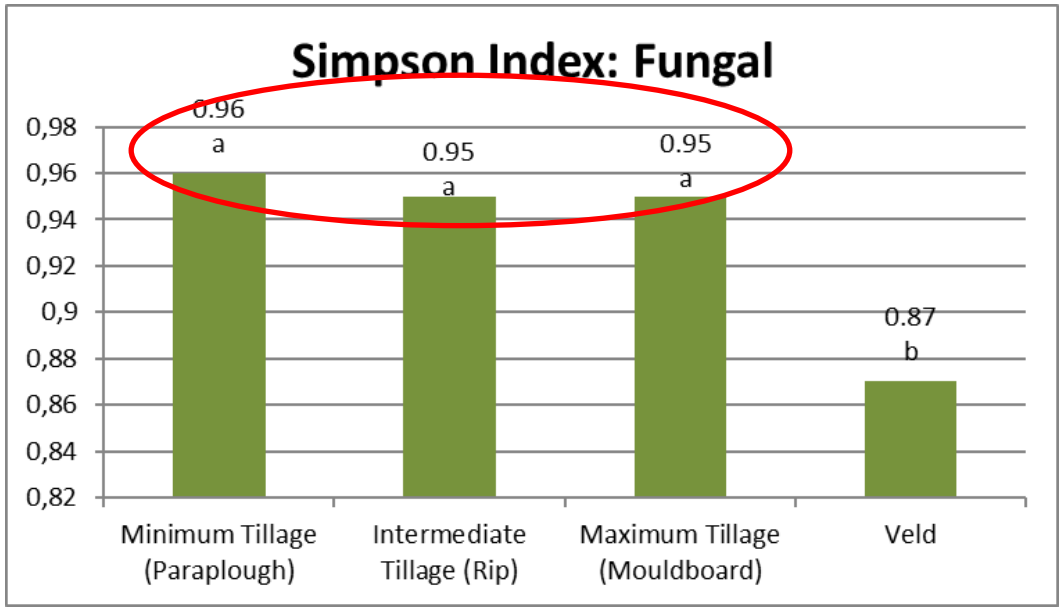


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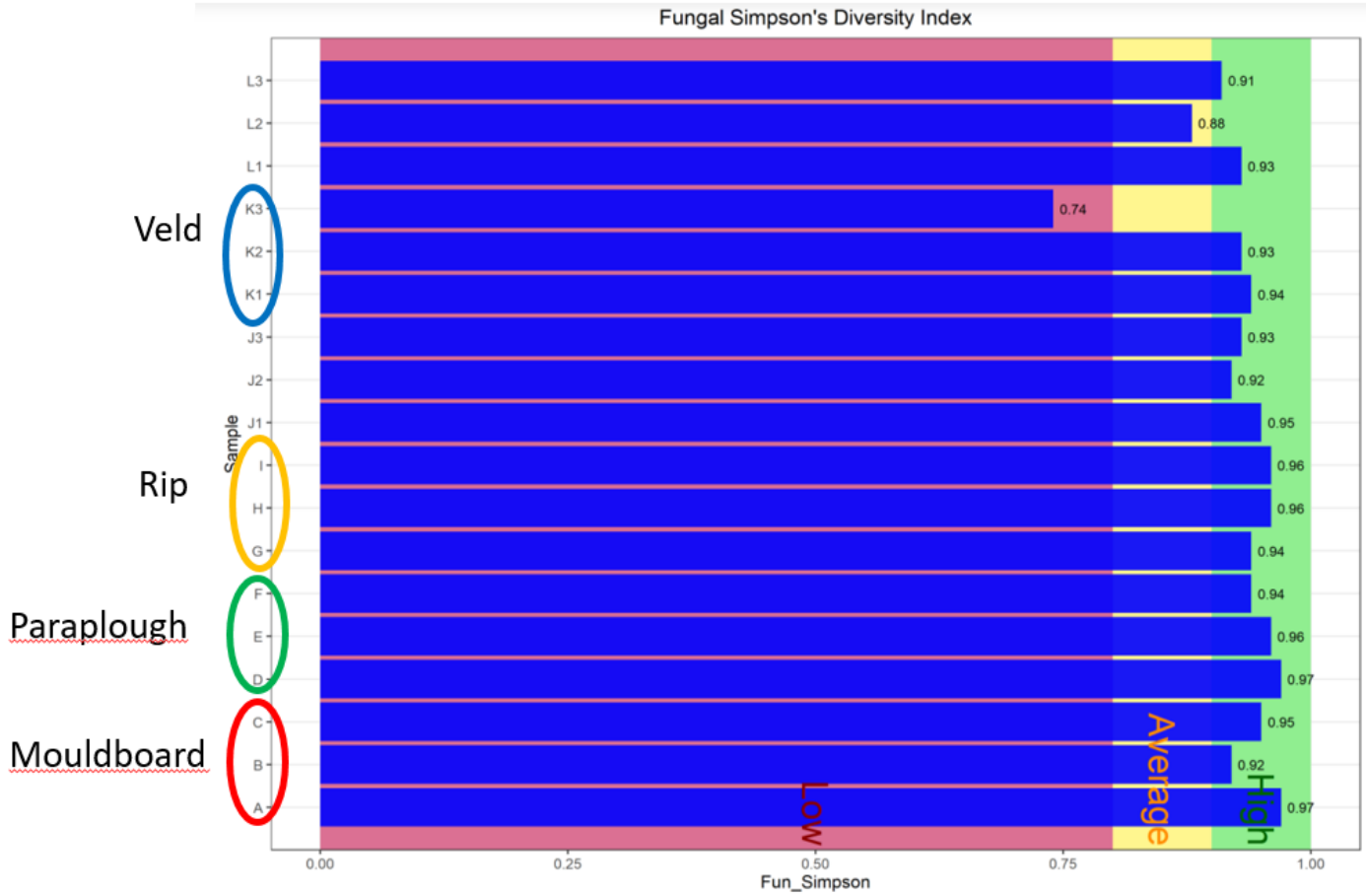

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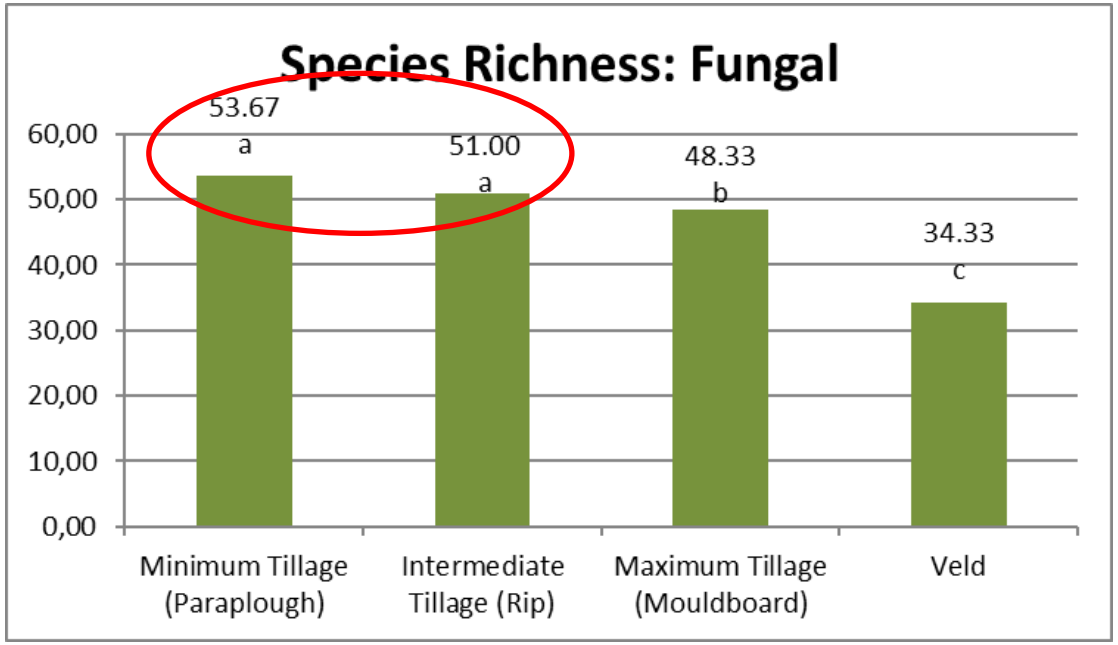


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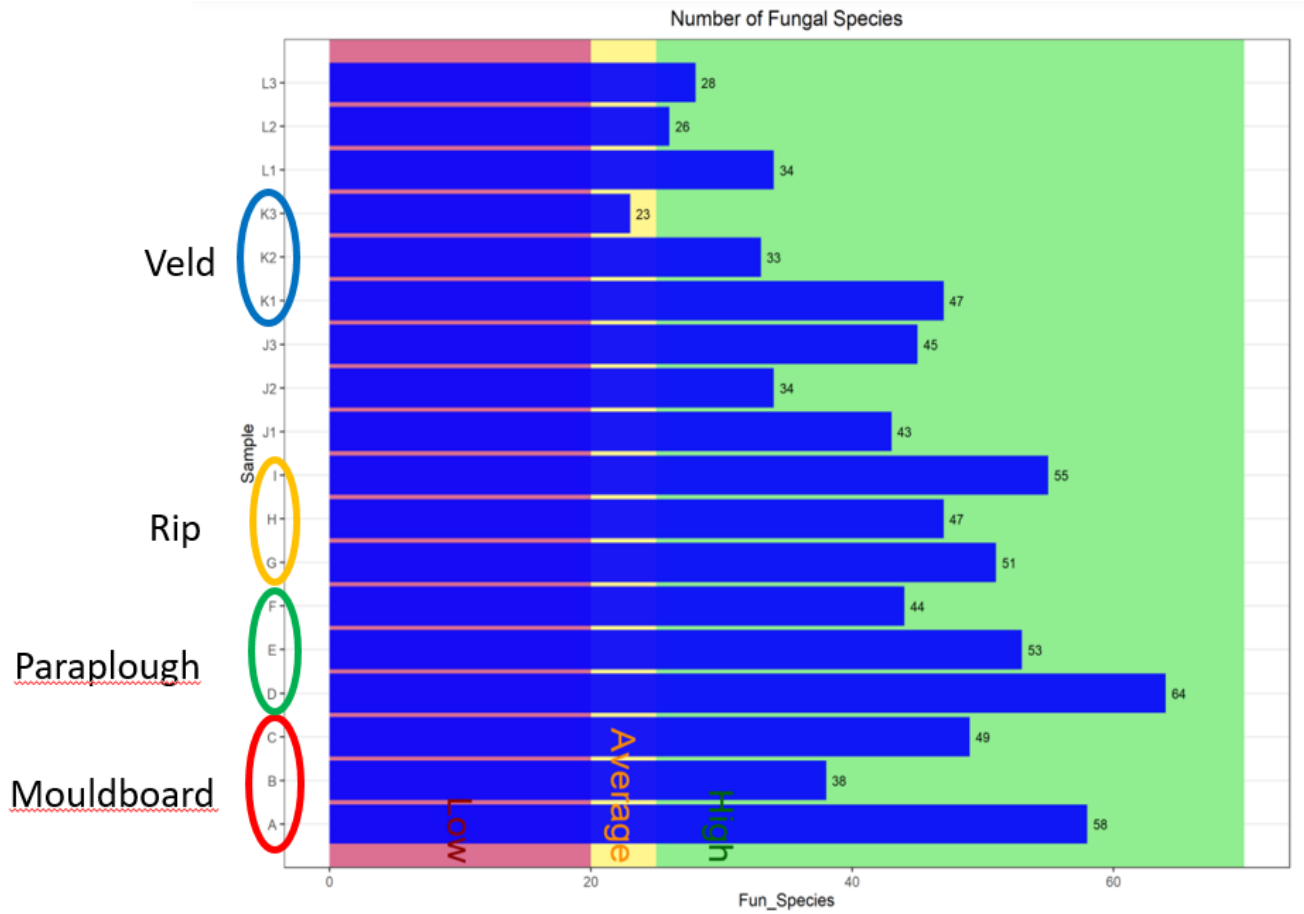


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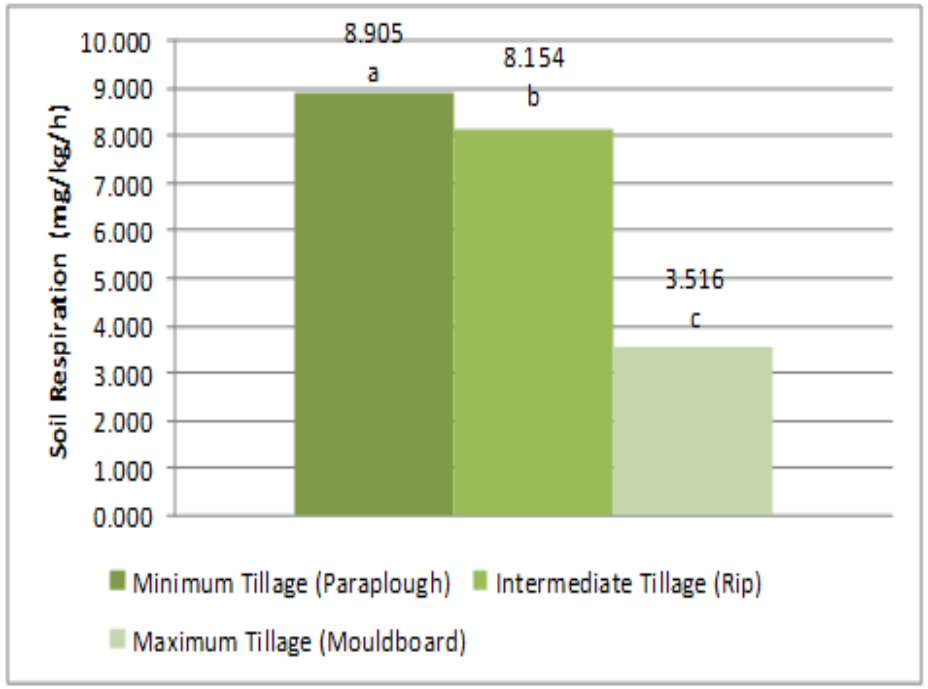
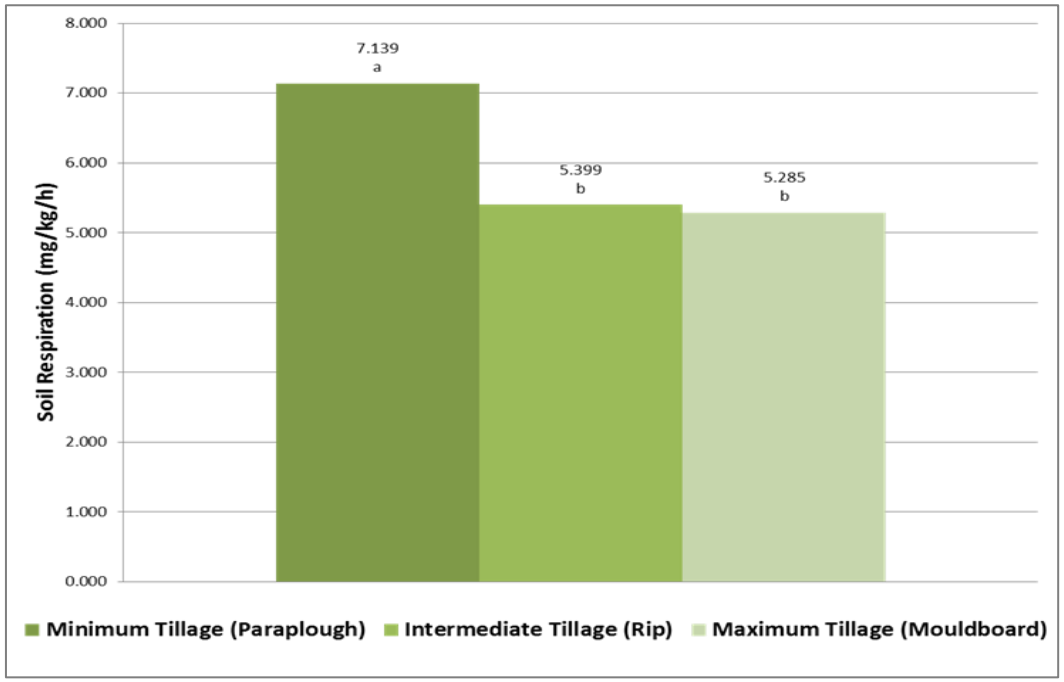
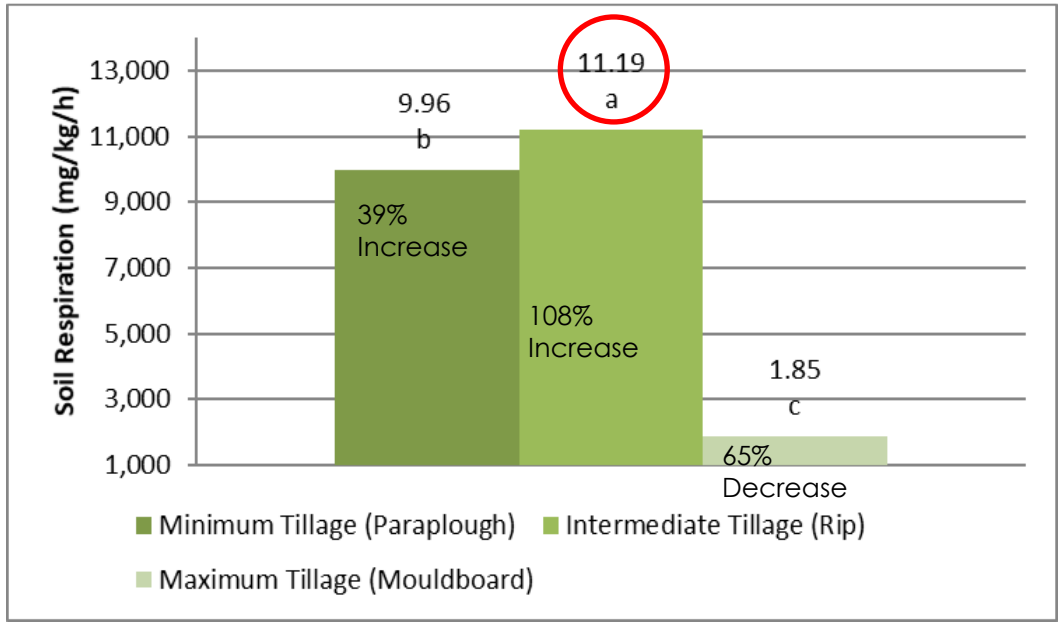
# Soil Respiration mg/kg/h




2018




2014

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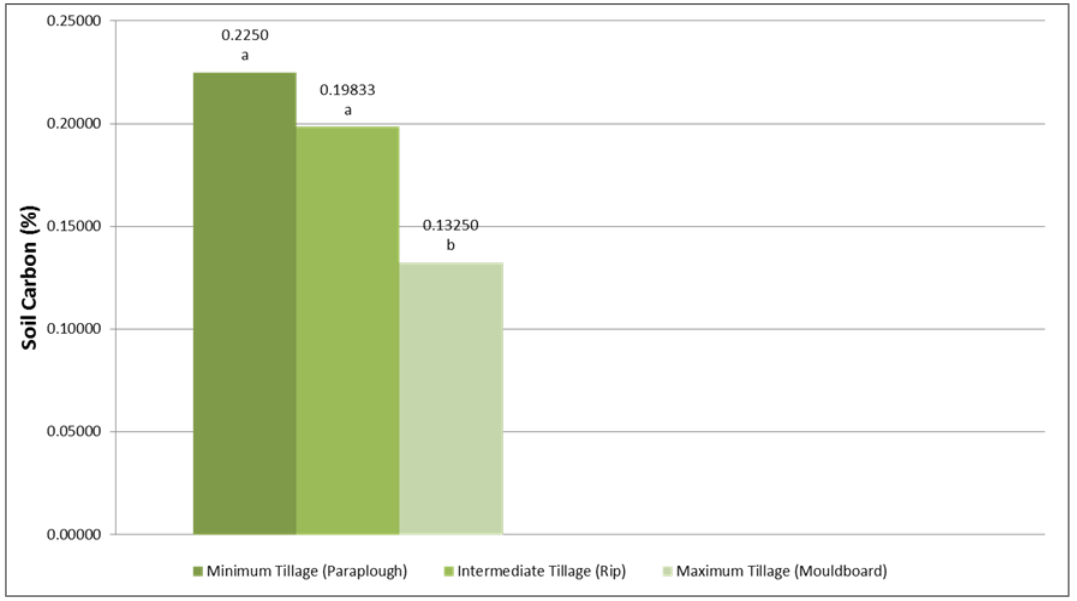
# Soil Carbon %

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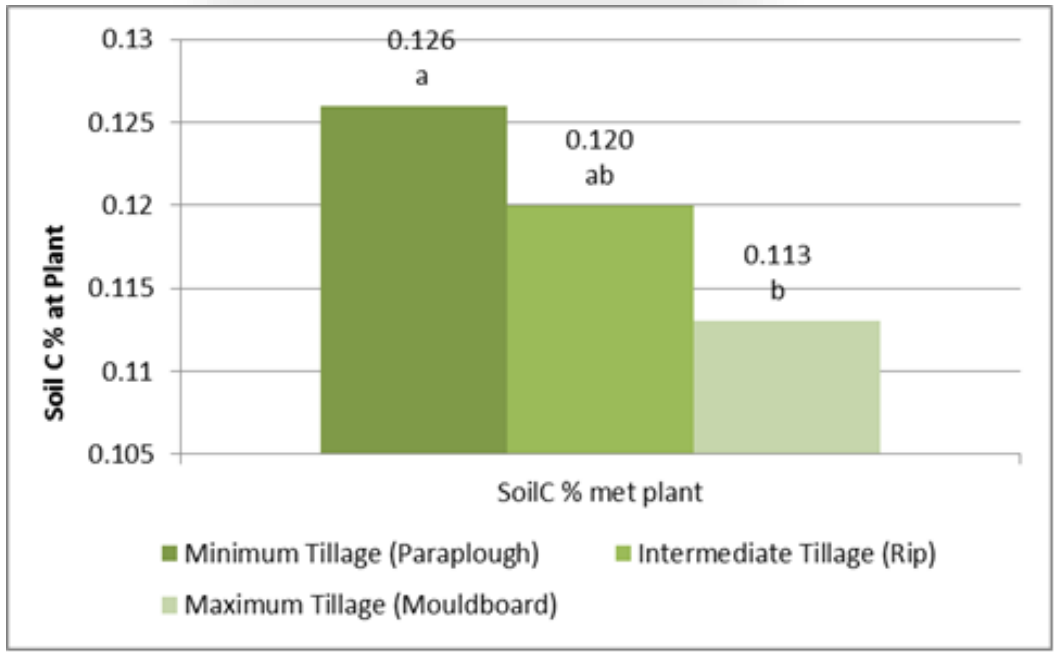


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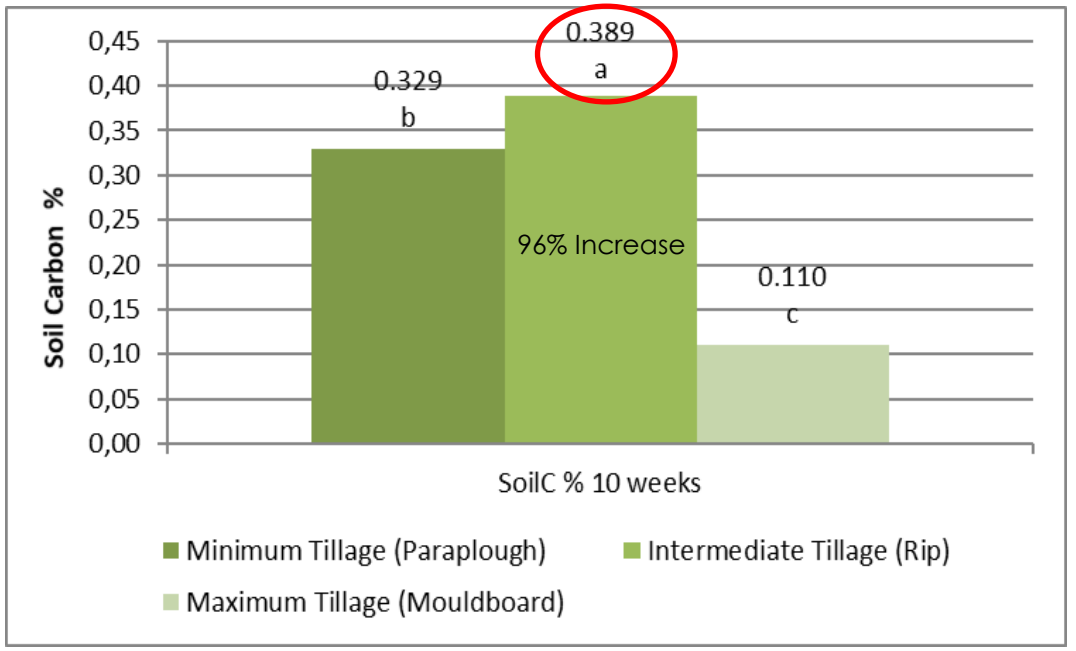
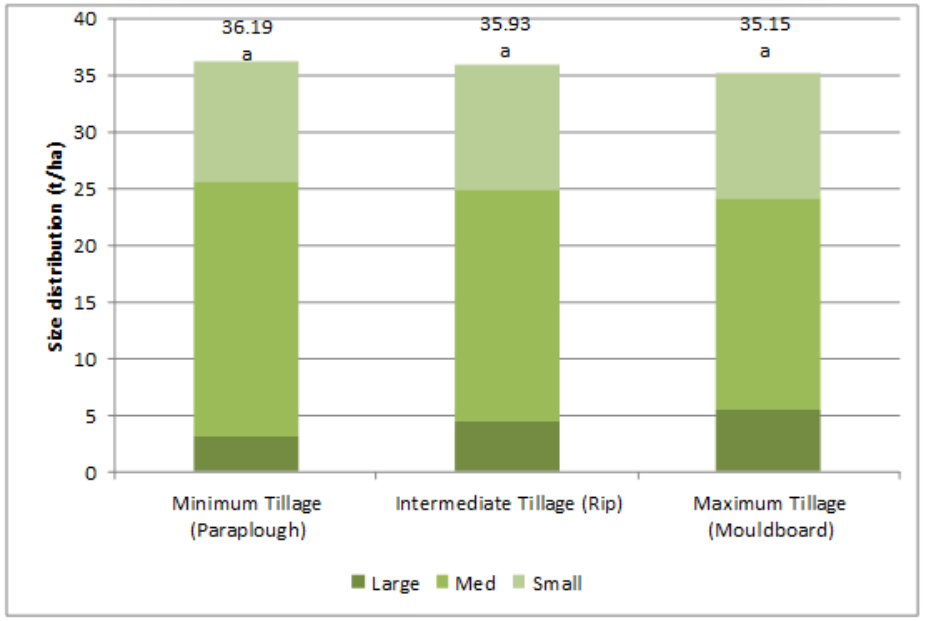



2022

# Yield and Size distribution

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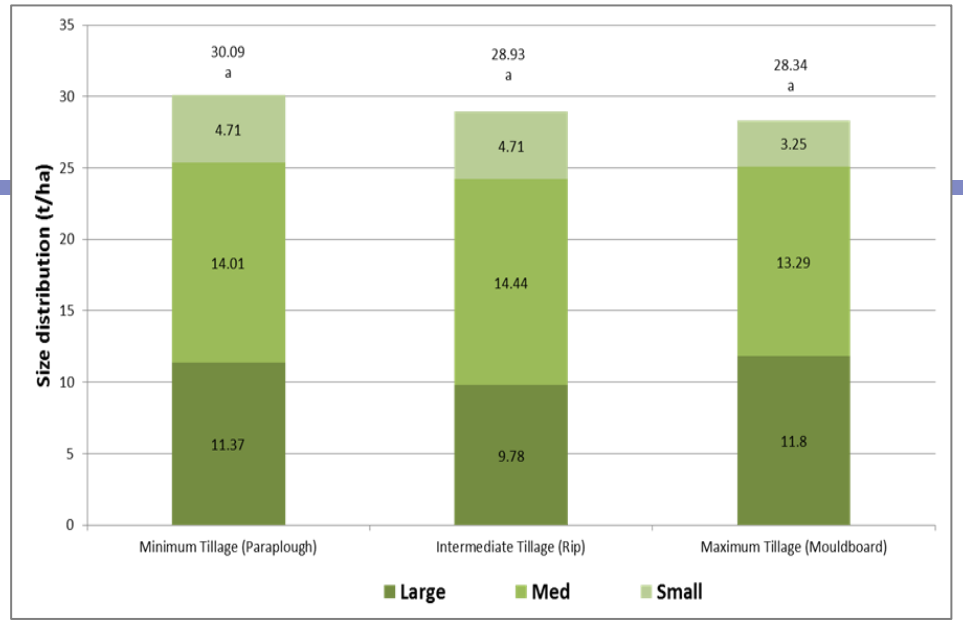
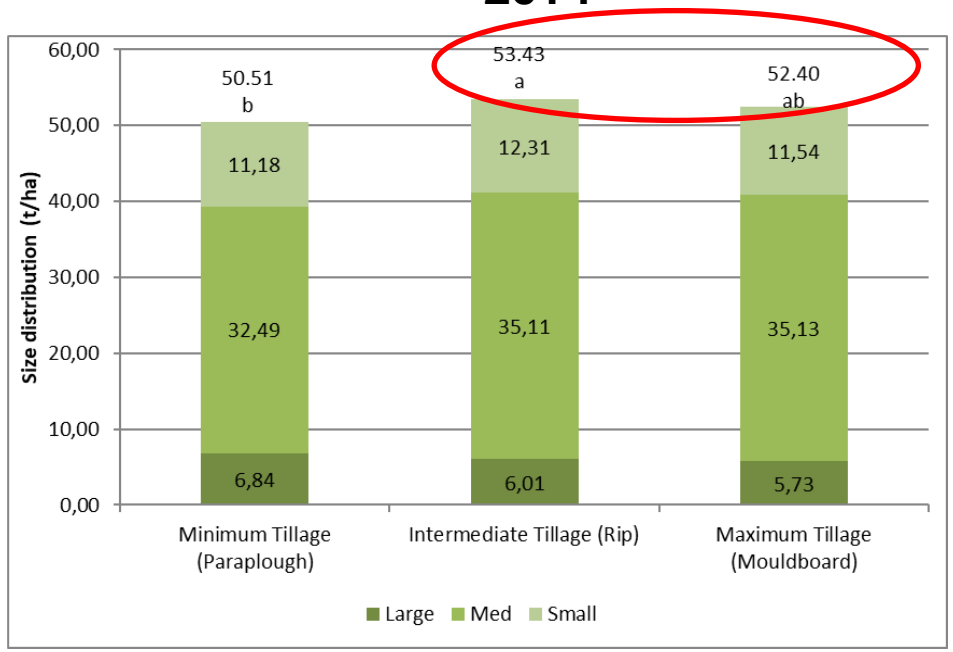



2014

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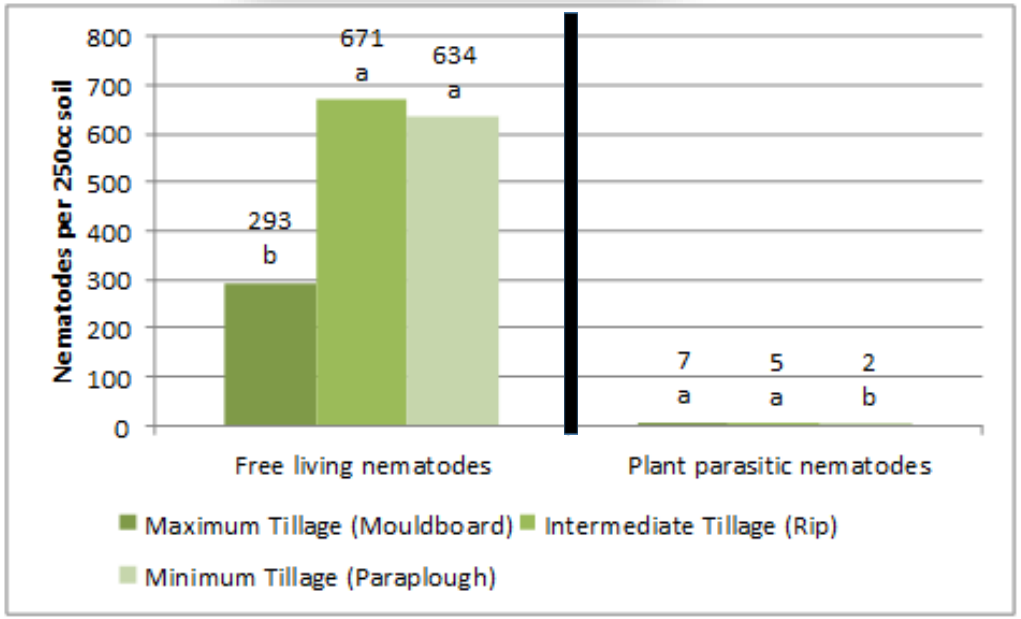
# Nematodes

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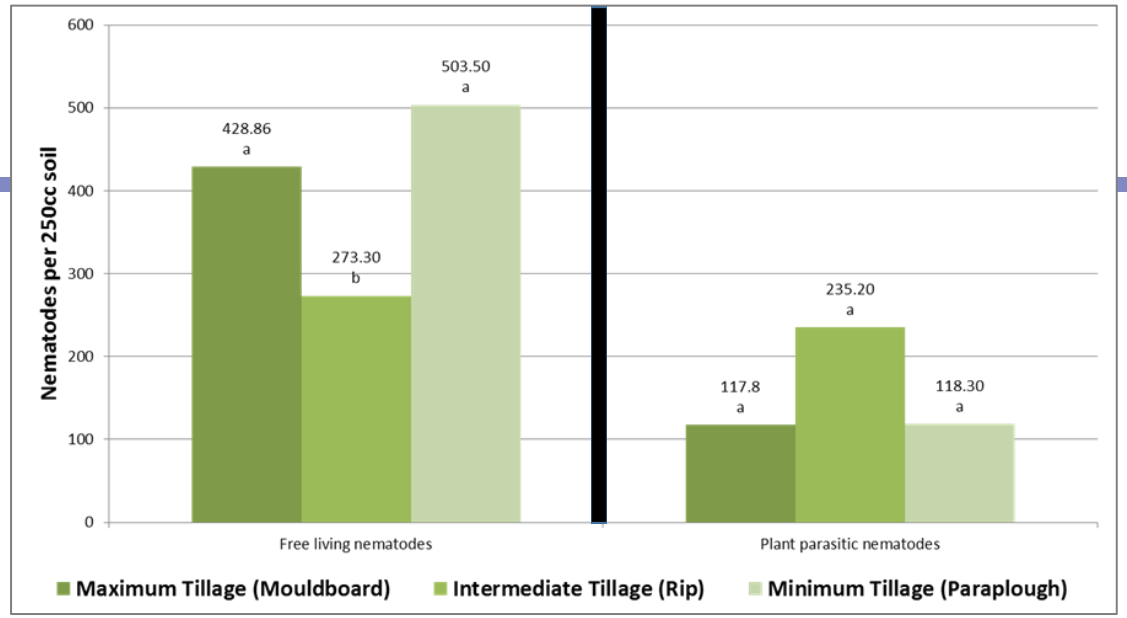


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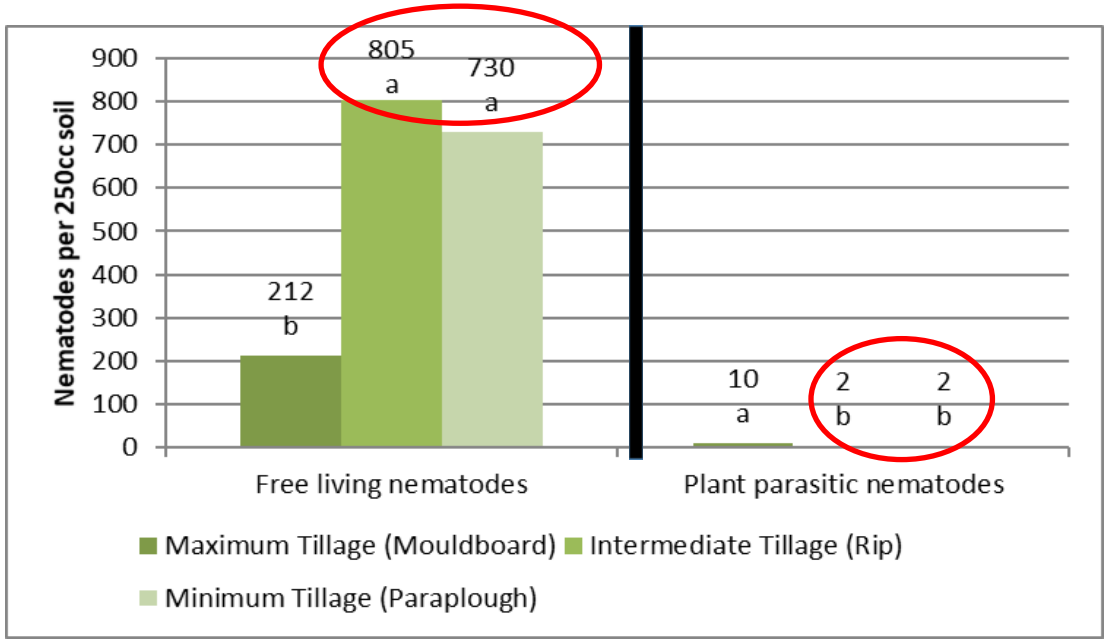


2022

# Conclusion:



| | Parapl | Rip | Mouldb |
|---|---|---|---|
| Bacterial: Shannon | ★ | ★ | |
| Bacterial: Simpson | ★ | ★ | |
| Bacterial: Species Richness | | ★ | |
| Fungal: Shannon | N/S | N/S | N/S |
| Fungal: Simpson | N/S | N/S | N/S |
| Fungal: Species Richness | ★ | ★ | |
| Soil Respiration | | ★ | |
| Soil Carbon | | ★ | |
| Yield | | ★ | ★ |
| Nematodes: Free Living | ★ | ★ | |
| Nematodes: Plant Parasitic | ★ | ★ | |

# Acknowledgements


- Co-worker: Albert de Villiers
- Potatoes South Africa
- Heinrich van Zyl
- Western Cape Department of Agriculture


Fisantevlug Boerdery

potatoes aartappels SA

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