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COMPARISON BETWEEN TWO CULTIVATION TECHNIQUES: NO-TILLAGE AND CONVENTIONAL TILLAGE APPLIED TO SOFT WHEAT CULTIVATION IN MOSTAGANEM, ALGERIA

**BOUKHATEM Hadjar ^{*1}, BENKHELIFA Mohammed², Danilo
RHEINHEIMER DOS SANTOS³**

¹Laboratory of Biotechnology Applied to Agriculture and Environmental Preservation
Higher School of Agronomy, Mostaganem (ESAM)

Email: h.boukhatem@esa-mosta.dz

²Abdelhamid Ibn Badis University (UMBA), Faculty of Natural Sciences and Life, Department of Agronomy

Email: benkhellifa@hotmail.com

³Department of Soil, Federal University of Santa Maria, 97.105.900 Santa Maria, Rio Grande do Sol, Brazil

Email: danilonesaf@gmail.com

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Abstract:

The objective of this study is to meticulously examine the distinctions between two agricultural methodologies, no-till (NT) and conventional tillage (CT), focusing on their influences on the physicochemical and morphometric attributes of both soil and crops. This investigation was conducted on a soft wheat crop (*Triticum aestivum* L.) at an experimental farm situated in the Mazagran commune, Mostaganem province, Algeria.

Keywords: No-Till, Conventional Tillage, Soil Moisture, Relative Water Content (Rwc), Thousand Grain Weight (Tgw), Soft Wheat.

Introduction:

Drought represents a significant global challenge, particularly exacerbated in arid and semi-arid regions by climate change and suboptimal agricultural practices that degrade soil and diminish its water retention capabilities. These issues are further compounded by mechanized farming, which promotes excessive evapotranspiration and thus intensifies water scarcity.

The preservation of soil against the perils of drought, erosion, excessive evapotranspiration, and the loss of organic matter is a critical challenge that necessitates innovative approaches from agricultural experts worldwide.

This study critically assesses no-till and conventional tillage practices to clarify their respective impacts on the physicochemical and morphometric characteristics of both soil and the soft wheat variety Ain Abid.

Materials and Methods:

The designated study area is an experimental farm located in the Mostaganem province on Algeria's western coast, which boasts a 124 km maritime front. Positioned west of Algiers, it is bordered by the Mediterranean Sea to the north and flanked by the provinces of Chlef to the east, Mascara and Relizane to the south, and Oran to the west (ANDI, 2013).

Our investigation involves a detailed comparison of the two tillage techniques and their effects on soil and plant properties, with data drawn from trials conducted from January 2020 through 2023, highlighting findings from the 2021 and 2022 campaigns. The locale is characterized by a semi-arid climate, with mild winters and annual rainfall varying from 350 mm on the plateau to 450 mm on the Dahra foothills (ANDI, 2013).

Experimental Setup:

The experimental framework is organized into complete blocks, each block comprising two treatment modalities: CT and NT. The plots are methodically arranged in dimensions of 20 x 8 meters (160 square meters), lined up in rows with designated corridors for access between the plots.

Work Equipment:

In executing our trials, we employed a variety of agricultural machinery, including a SANALIKA brand tractor (DL_75RX) boasting 110 horsepower, a three-disc plough, a cover crop machine, and a carried sprayer with a 400-liter capacity for chemical weeding and subsequent seedbed preparation.

Methodology:

The tillage process involved plowing to a median depth of 25 cm using a three-disc plow, followed by breaking up the stubble with a cover crop implement. This preparation aims to optimize soil structure and readiness for sowing.

The no-till seeding technique entailed direct manual broadcasting of seeds at a rate of 2.24 kg per plot. Seeds were sown at a median depth of 5 cm and spaced 20 cm apart in rows, facilitating a minimal disturbance approach to soil management.

Parameters Discussed:

This study meticulously examines a variety of physical, chemical, and morphometric parameters. We prioritize three essential parameters for detailed analysis:

1. Soil Moisture (H%):

Soil moisture was calculated using the gravimetric method (Petard, 1993; Duchaufour, 1997) with the following formula:

$$H\% = (P_f - P_s) / P_s \times 100$$

Where:

- P_f : Fresh weight
- P_s : Dry weight

Monitoring soil moisture is conducted throughout the vegetative cycle of the crop on a weekly basis. This monitoring has enabled us to understand the effects of the two techniques on soil moisture and on crop development from another perspective.

2. Relative Water Content (RWC):

Starting from the tillering stage, the RWC was determined weekly during both campaigns. Relative water content is a crucial parameter for assessing a crop's response to water stress as indicated by Braham (1977), who noted that a plant's water deficit state is characterized by a drop in its RWC.

RWC was determined using the method proposed by Westerly (1950), Castsky (1974), and Turner (1981) with the following formula:

$$RWC : (P_f - P_s) / (P_t - P_s) \times 100 \text{ (Laouar, 1977)}$$

- P_f : Fresh weight (g)
- P_s : Dry weight (g)
- P_t : Turgid weight (g)

3. Thousand Grain Weight (TGW):

TGW was determined by weighing the harvest of 1,000 grains from each elementary plot for both no-till and conventional tillage during the 2020/2021 and 2021/2022 campaigns. A variance analysis of the collected data was conducted using the ANOVA test as outlined by Neuwmen and Keuls, with a significance threshold set at 5%.

Results and Discussion:

Soil Moisture:

For both techniques (SD and LC), the Thousand Grain Weight (TGW) is determined by weighing the harvest of 1000 grains from each elementary plot during the two campaigns (2020/2021 and 2021/2022).

Variance analysis of our results was conducted using the ANOVA test by Neuwmen and Keuls, with a significance threshold of 5%.

Results and Discussion:

1. Soil Moisture:

Soil moisture monitoring was conducted over more than three months, collecting samples weekly for both SD and LC techniques during the 2020/2021 and 2021/2022 campaigns.

Table of Soil Moisture Results for the Two Years:

Descriptive Statistics of Soil Moisture for the Two Years:

Moisture	Mean	Median	Min	Max	SD	CV
H_LC	11.36	9.52	3.54	66.34	12.08	
H_SD	10.68	9.45	3.79	32.27	5.55	51.91

ANOVA / p-Value = **1.998e-10 *****

There is a highly significant difference in soil moisture levels between Conventional Tillage (LC) and No-Till (SD).

CV: Coefficient of variation; $CV = cv = sd/mean * 100$

Mean: Average

Min: Minimum value

Max: Maximum value

SD: Standard deviation

Statistical Analysis:

ANOVA

Analysis of Variance Table

Response: pp3\$LC

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
SD	1	2841.20	2841.20	121.49	1.998e-10 ***
Residuals	22	514.52	23.39		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

P value = 1.998e-10 ***

The p-value of 1.998e-10 indicates a highly significant difference in soil moisture levels between Conventional Tillage (LC) and No-Till (SD).

This means that the difference in soil moisture between LC and SD is very highly significant.

Analysis of data across the two campaigns revealed marked variability in soil moisture between the two practices, with no-till (SD) consistently demonstrating higher moisture retention than conventional tillage (LC). This variability correlates directly with the climatic factors, such as precipitation and temperature-driven evapotranspiration.

Notably, soil moisture levels in the no-till plots remained superior, particularly during the critical period from April to June. The no-till plots, shielded by a cover crop, exhibited enhanced water retention capabilities, effectively reducing evapotranspiration during periods of elevated temperatures.

Additionally, referencing El Mezoued (2017) and Mrabet (2011), the protective cover in no-till plots extends the soil drying process and retains moisture for longer durations compared to exposed soils in conventional tillage. This characteristic makes no-till an exceptionally viable strategy for soil conservation and moisture management in arid and semi-arid regions, prone to drought conditions.

2. Relative Water Content (RWC):

Table of RWC for the Two Years:

Descriptive Statistics:

	Mean	Median	Min	Max	SD	CV
LC	105.56	83.53	21.12	960.98	165.02	
SD	116.78	83.50	15.96	1155.56	200.15	

ANOVA Test:

Analysis of Variance Table for RWC (LC)

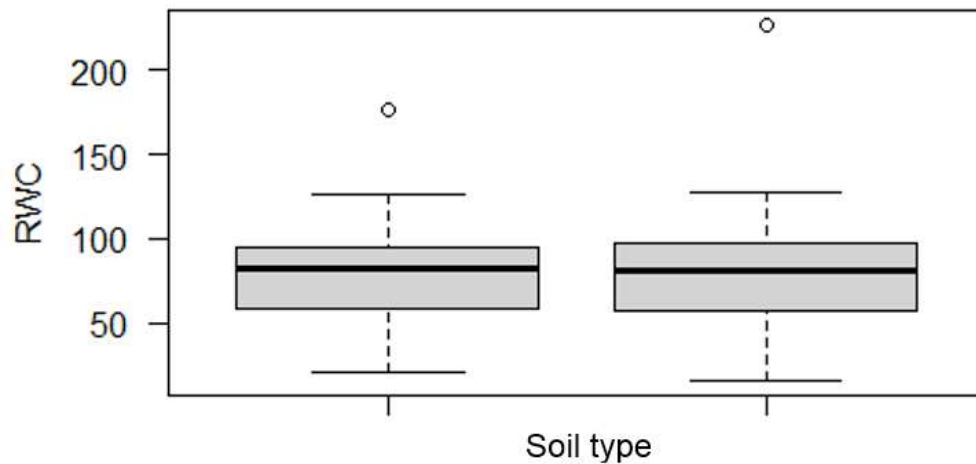
`anova(mod)`

Analysis of Variance Table

Response: RWC\$LC

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
SD	1	3153	3152.8	0.1122	0.7401
Residuals	28	786566	28091.7		

Non-significant difference, p-value = 0.74 >> 0.05



The results for Relative Water Content (RWC) show a higher average in plots managed with No-Till (SD) compared to those managed with Conventional Tillage (LC) during the two campaigns.

It is crucial to remember that RWC (Relative Water Content) is a relevant factor indicating the water status of a plant and its physiological functioning. It is considered a more reliable parameter than other water potentials under drought conditions to assess a crop's response to water stress.

In our case, the No-Till (SD) technique proves more effective due to the consistent presence of vegetation cover, which reduces the phenomenon of evapotranspiration. This, in turn, positively affects the behavior and development of the crop.

3. Thousand Grain Weight (TGW):

The following results were observed for TGW during our extensive two-year study:

Table of TGW Results for the Two Years:

Descriptive Statistics

	mean	median	Min	max	sd	CV
P.G.ha._LC	30,76	16,42	12,13	74,45	22,79	74%
P.G.ha._SD	29,76	20,25	10,5	68,56	22,48	75%
PMG_LC	41,06	43,15	34,18	46,5	4,93	12%
PMG_SD	42,64	41,4	37,46	48,2	4,56	11%

CV: Coefficient of Variation

Mean: Average

Min: Minimum Value

Max: Maximum Value

Sd: Standard Deviation

Significant variability is observed within each soil type regarding seed weight per hectare (74% - 75% for LC and SD respectively). Conversely, variability is lower for the TGW parameter (11% - 12%).

Statistical Test:

ANOVA

```
> anova(mod)
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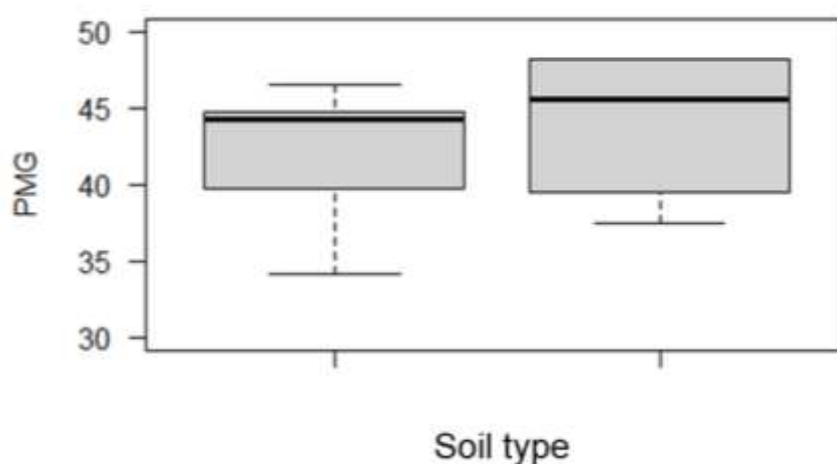
Analysis of Variance Table

Response: pp1\$PMG_LC

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
PMG_SD	1	89.890	89.890	8.0215	0.03658 *
Residuals	5	56.031	11.206		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Significant difference in TGW between LC and SD P value = 0.036 << 0.05



This analysis confirms a significant difference in Thousand Grain Weight between the No-Till (SD) and Conventional Tillage (LC) practices, suggesting that No-Till may provide better conditions for grain development under the conditions studied.

This detailed statistical insight provides a robust framework for understanding the impact of different tillage practices on crop yield, offering valuable insights for agricultural management.

Conclusion:

In agricultural practices, the relentless pursuit is to implement techniques that guarantee optimal crop yields, necessitating a soil environment that maintains a harmonious balance of water and air. The impressive yields observed during the two monitoring campaigns substantiate the

advantages of No-Till (SD) farming in promoting plant growth and enhancing wheat production. This method provides effective hydration, especially critical during the final growth stages of the crop cycle, which often coincide with drought conditions.

Thousand Grain Weight (TGW) acts as a vital indicator of water availability during the grain filling phase, as demonstrated by the water index. This index highlights significantly better soil moisture retention in plots managed with No-Till (SD) compared to those under Conventional Tillage (LC).

While the shift to No-Till farming presents its challenges, requiring patience and persistence, our longitudinal study, spanning 12 years on No-Till managed plots, has yielded increasingly positive outcomes annually. However, it is important to underscore that a primary challenge in this farming technique is effective weed management, particularly with quackgrass.

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