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# SOIL FERTILITY IMPROVEMENT UNDER CONSERVATION AGRICULTURE. EFFECT OF FERTILIZATION ON SOIL PHYSICO-CHEMICAL PROPERTIES AND WHEAT YIELD UNDER BOTH CONVENTIONAL AND NO-TILL SYSTEMS

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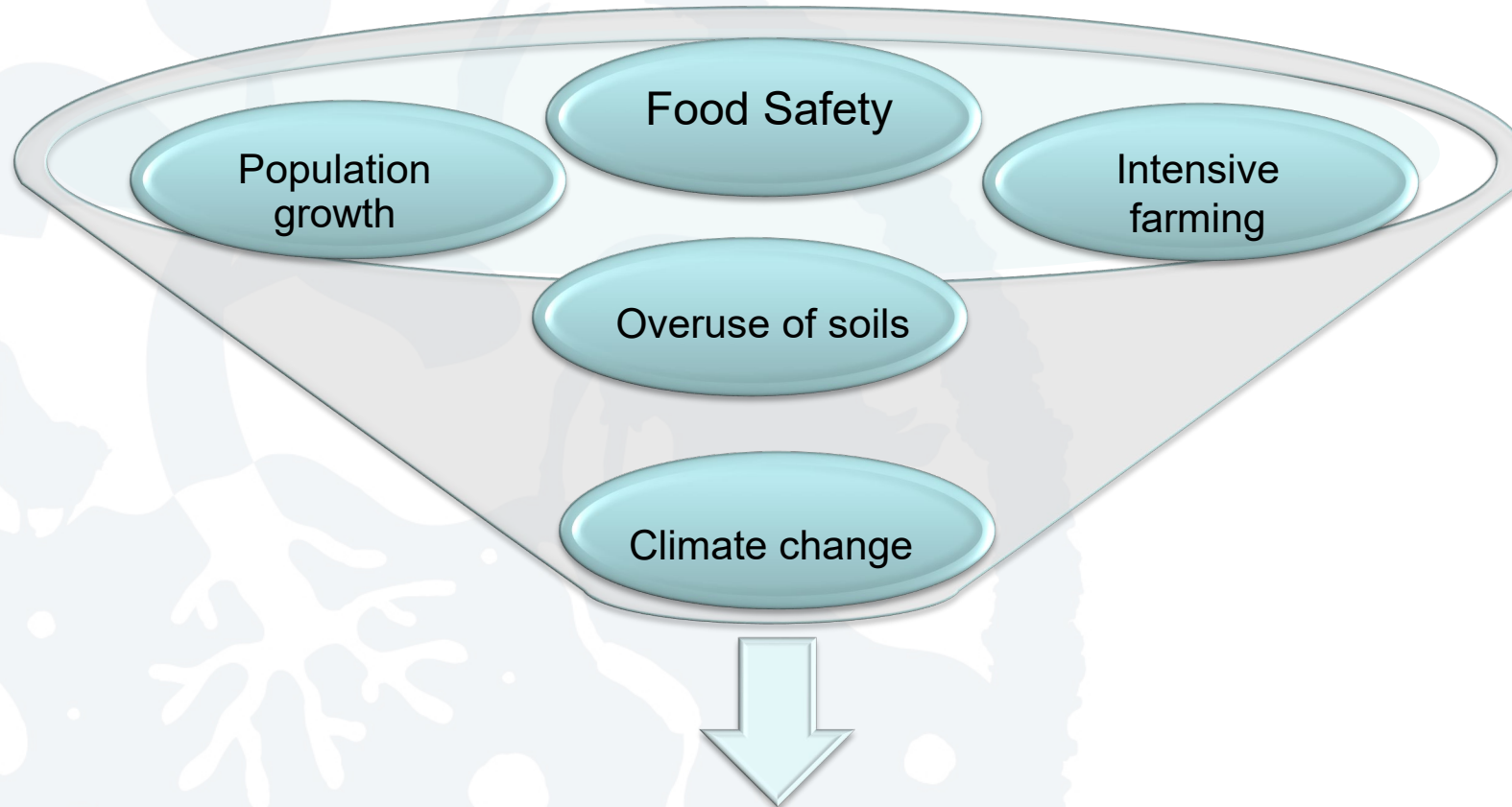
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## Outline

- 1 INTRODUCTION
- 2 Presentation of the region
- 3 Methodology
- 4 Laboratory analysis
- 5 Results & Discussion
- 6 Conclusion

## Problematic & Research subject



**Soil degradation and Water shortage**

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## Problematic & Research subject

# Soil degradation Water shortage



➤ Hypothesis : - No-till application (NT)

➤ Objective



Study

NT effect

Compared NT and  
conventional tillage (CT)

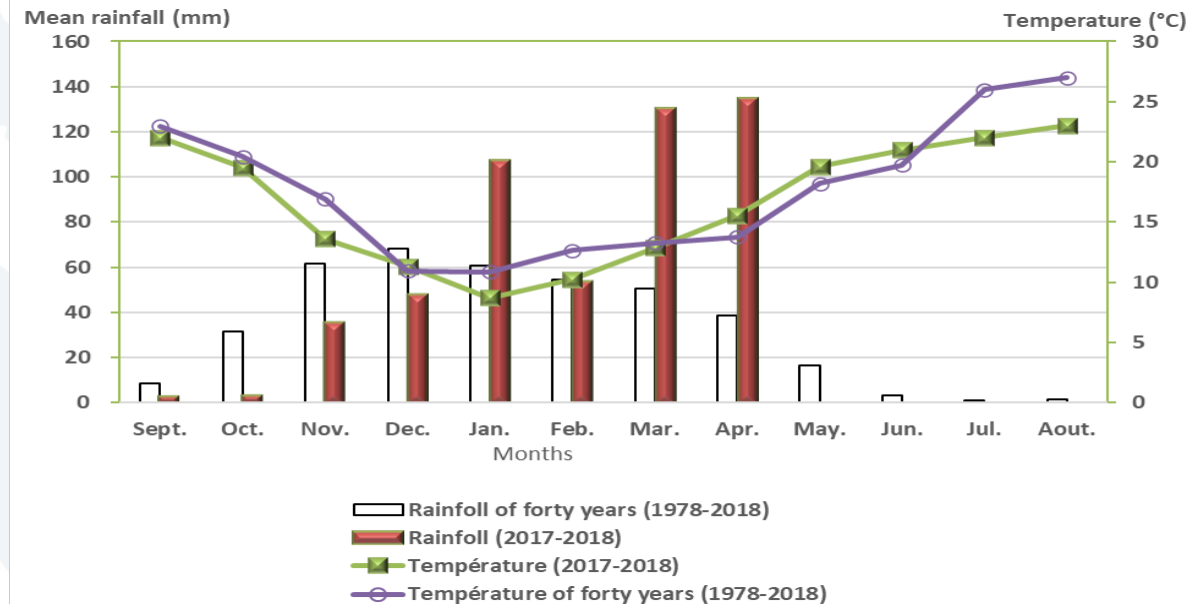
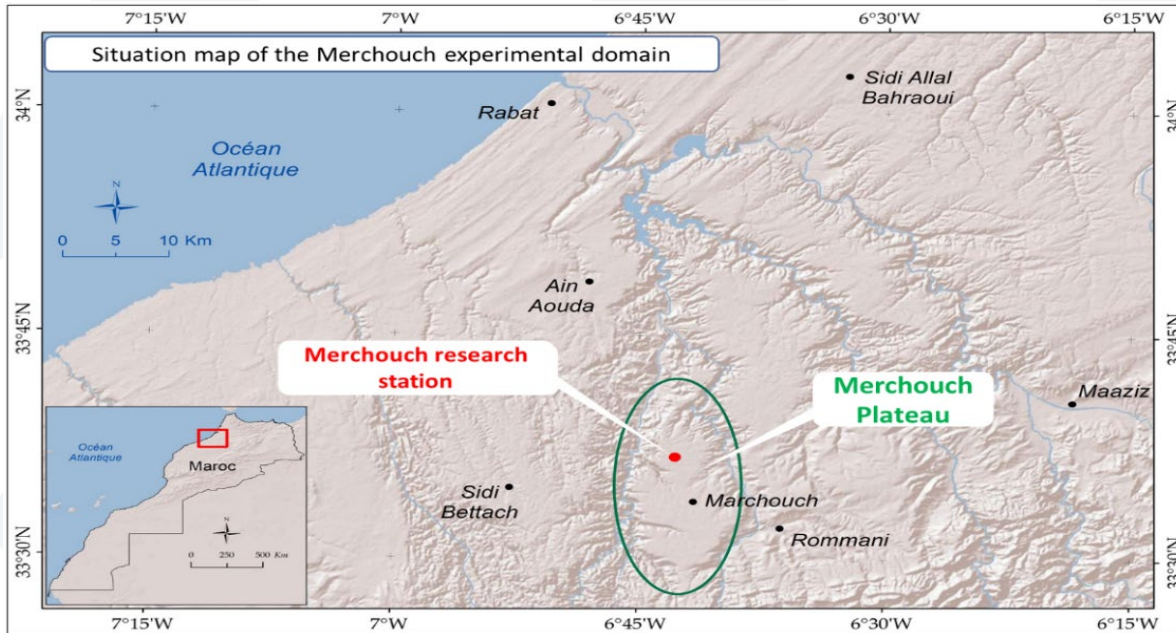
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## Choice of experimental site: Merchouch site

### Long-term comparative trials between NT and CT


- The experiment has been installed on this site since 2005
- The long-term test is carried out on two adjacent plots of 200 m in length and 100 m in width each
- The plots are fenced and without grazing
- The rotation practiced is legumes/cereals
- Crop management was similar in CT and NT treatments.
- Conventional tillage (CT), with Stubble Plow and Cover Crop, was carried out in plowed plots on the first centimeters (from 10 to 15 cm deep
- NT, which consists of an opening 2 to 3 cm from the ground to deposit the seed at a depth of 5 cm, is produced using a special direct seed drill.

## Research site and experimental protocol




The Merchouch experimental site (located at 33.567° N latitude and 06.633° W longitude, and is 255 m above mean sea level)

### Climate: semi-arid


**Precipitation: 295 mm (annual average)**


**Temperature: Varies between 5°C and 31°C (TM°: 18°C)**


**Winds: West and South-East: Chergui**

## Conservation Agriculture (CA)

Crops do not require ploughs or discs... they require good soil conditions for germination and growth.

**CA is a cropping system that can prevent the loss of arable land while regenerating degraded land, for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment**

- ① Minimize soil disturbance, compatible with sustainable production.
- ② Maximize soil surface cover through crop, pasture and crop residue management.
- ③ Stimulate biological activity through crop rotation, cover crops and crops and integrated nutrient and pest management.







## No till (NT)

Direct seeding is defined by a total absence of tillage (no turning, no loosening, no seedbed preparation). The physical characteristics of the soil favorable to the development of crops are obtained solely by the action of the climate and the biological activity of the soil (roots, animals, micro-organisms) and preserved by a permanent cover.

(Boudiar,2013).



## Methods

### Physico-chemical characterization of soils



Soil moisture  
gravimetric



Structural stability Le  
Bissonais



Granulometry  
Sedimentation



Bulk density Grossman and Rein



SOM Walkley and Black



Total nitrogen  
Kjeldahl



Potassium Ammonium  
acetate



Phosphorus Olsen



## Results

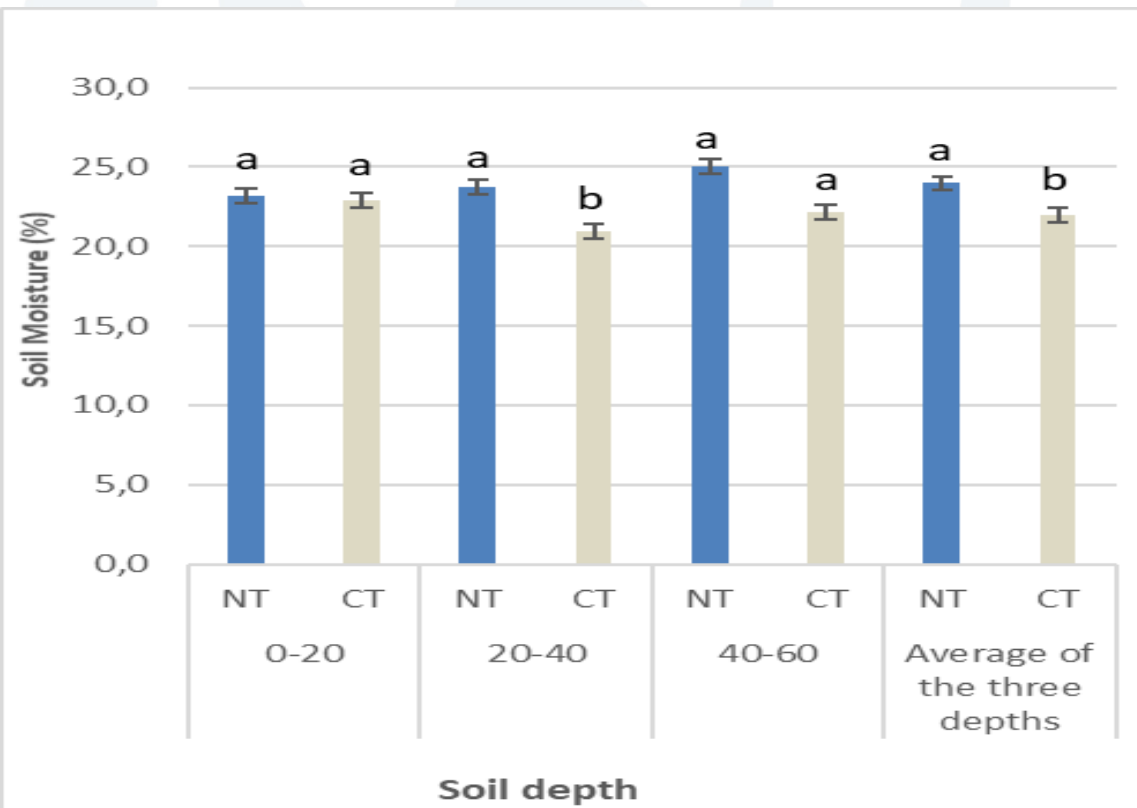
# Particle size characteristics of the soil

Profile – Champ	Duration	Soil depth (cm)	Clay (%)	Silt (%)	Sand (%)	Limestone Total (%)	Texture	Soil type
SP-Site Merchouch	16 ans	0-20	51.0	36.1	12.7	2.8	Clay	Vertisol
		20-40	50.2	38.6	11.2	3.3		
		40-90	52,5	35.1	12.4	13.5		
		90-140	53	32.1	14.9	18.5		



## Results

# Soil moisture



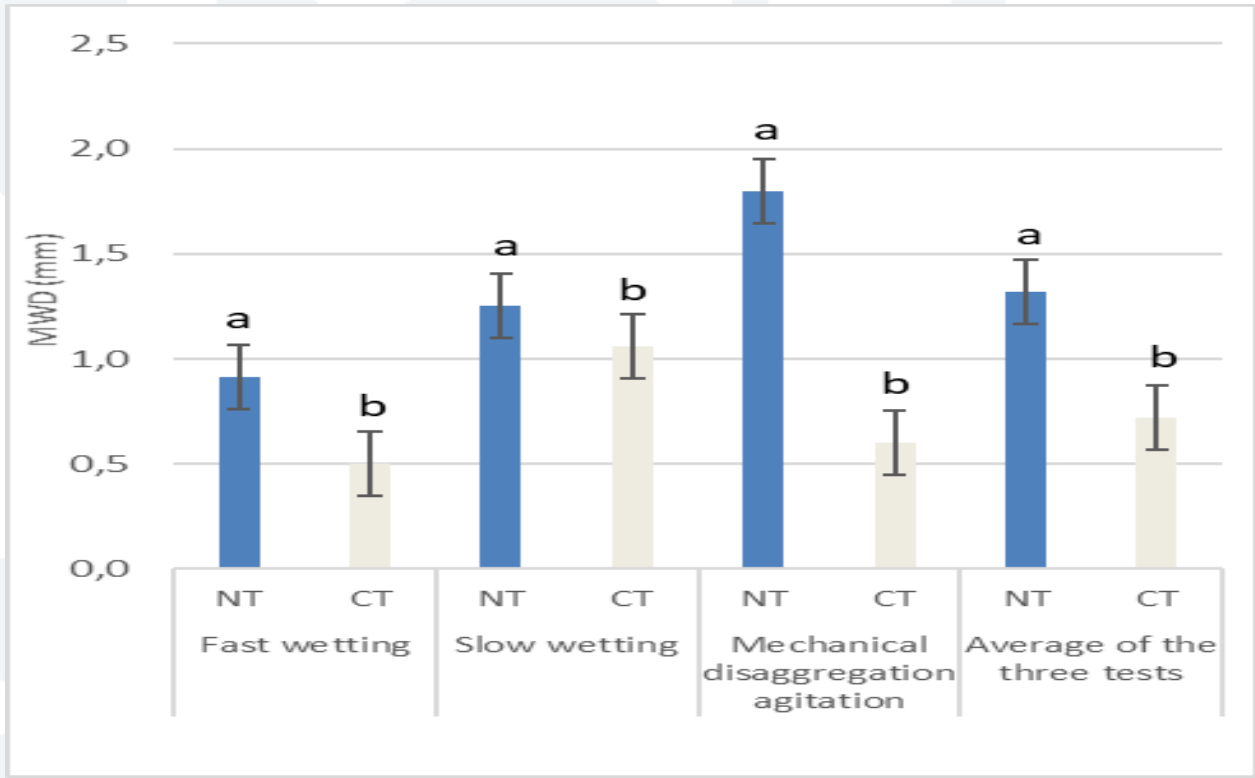
NT plots have a moisture content that increases from 23% at the surface to 25% at depth, showing that NT provides better water retention than CT in low rainfall areas.

With NT, the deeper horizon also retains more moisture, showing that this system conserves water. In contrast, with CT, plant residues are buried and the exposed surface of the tilled soil is much larger, resulting in greater evaporation of water from the upper horizon.

Effect of the two cultural practices (NT and CT) on moisture (%). Treatments with the same letter are not significantly different according to Duncan's test ( $P < 0.05$ ).

Results

# Structural stability



The results of the soil structural stability tests show that there is a significant difference between the two practices for all three tests.

For the slow rewetting test, the NT soil shows a weight average diameter (MWD) value of 1.8 mm, significantly higher than for the CT soil (0.6 mm).

This shows that the stability of the aggregates was higher under NT than under CT.

Effect of tillage on weight average diameter (MWD) for three tests (fast wetting, slow wetting, and mechanical disaggregation) at the soil surface (0-20 cm).

## Results

# Organic matter

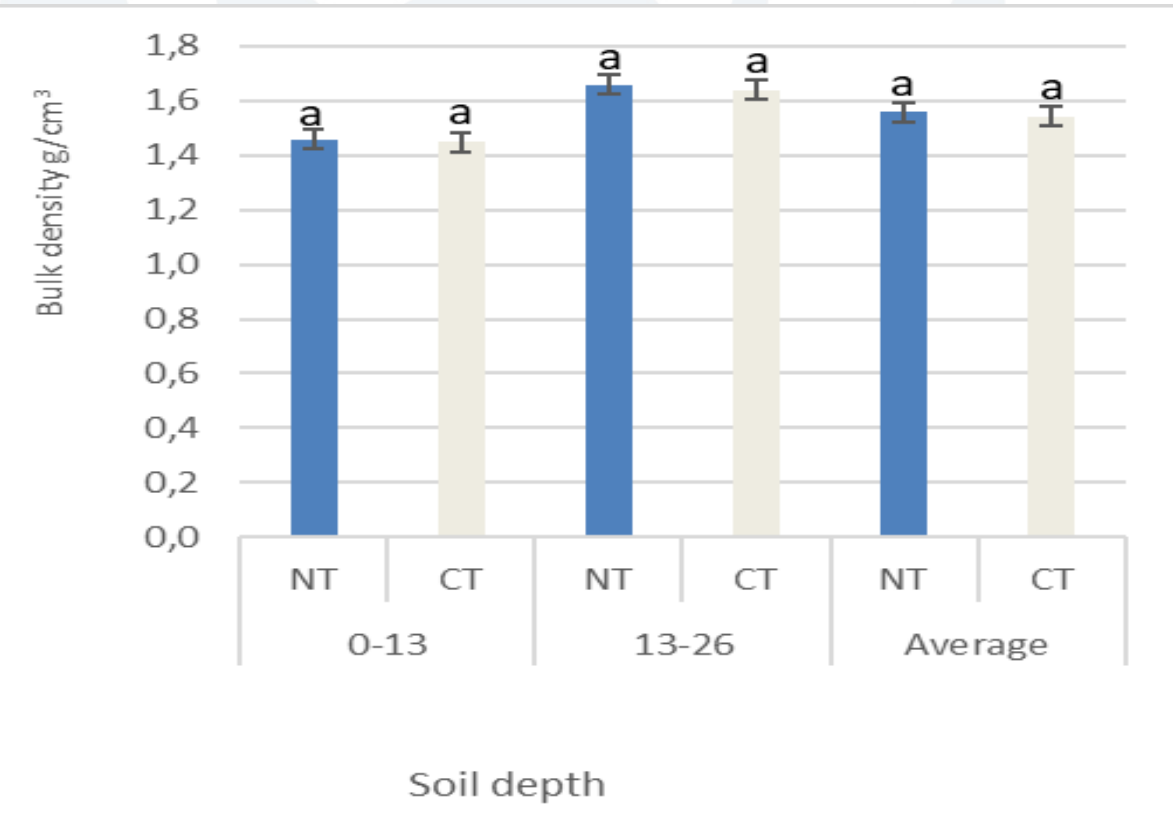
Effect of tillage on soil organic matter (SOM)

Field	Number of years of NT adoption	Soil depth (cm)	Soil organic matter (%)		Rate of change (%)
			NT	CT	
Site of Merchouch	13 years	0-5	1.81 ± 0.24a	1.35 ± 0.14b	34
		5-10	1.68 ± 0.31a	1.37 ± 0.16b	23
		10-20	1.55 ± 0.27a	1.25 ± 0.18b	24
		20-40	1.43 ± 0.21a	1.10 ± 0.24b	29
		40-60	1.25 ± 0.18a	1.00 ± 0.26b	26

At the Merchouch site, SOM content is higher in NT than in CT at all depths. According to the statistical test, the difference in SOM content between NT and CT is significant at all depths. SOM content decreases with depth because crop residues are not buried and decompose on the surface.

No till (NT)

# Bulk density



Bulk density was high under NT (> 1.4 g cm<sup>-3</sup>) and reached 1.66 g cm<sup>-3</sup> under NT in 13-26 cm.

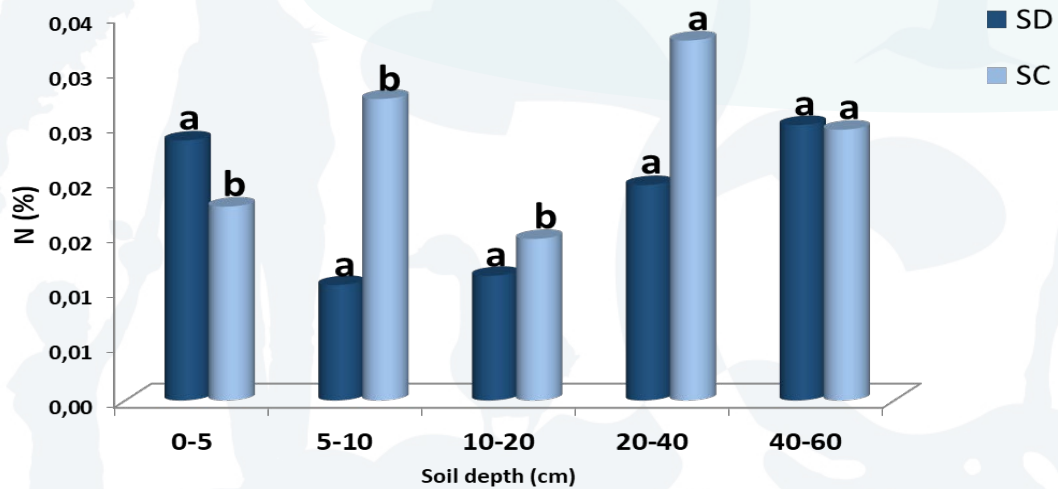
The bulk density at the soil surface (0-13 cm) was slightly higher under NT (1.5 g cm<sup>-3</sup>).

Effect of tillage on bulk density at 0-13 and 13-26 cm depth for NT and CT.

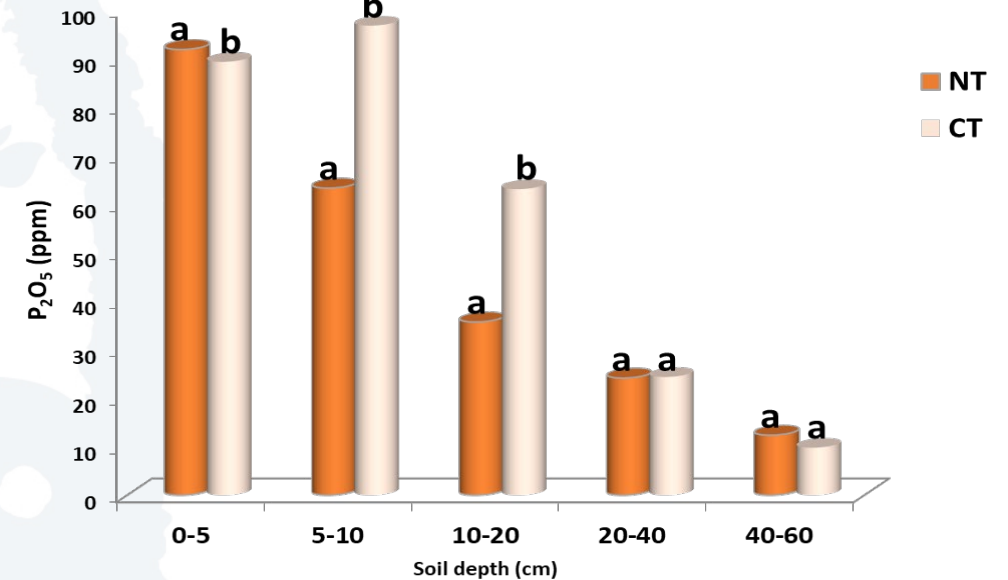
# Results

## NPK nutrients

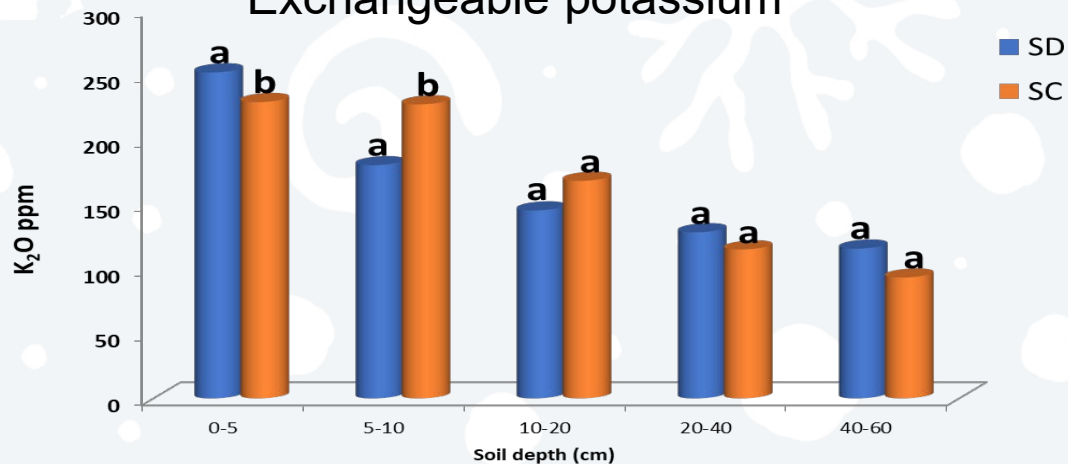
### Total nitrogen rate



### Available phosphorus



### Exchangeable potassium





## Conclusion

### **This work allowed us to study the effect of no till on the physical and chemical properties of the soil at the Merchouch site :**

- This study showed the effectiveness of conservation agriculture as a sustainable soil management approach to improve the quantity and quality of organic matter in soils
- This study also showed the real existence of positive changes in the distribution of physical and chemical properties of soils under NT compared to CT.
- The results showed that the use of the NT system significantly influences the accumulation of SOM, especially at the soil surface horizon (0-5 cm). Regarding moisture, there is a significant difference between the two treatments (NT and CT) at the average of the three depths and especially at the 20-40 cm horizon, so NT increases the water holding capacity.
- This study also showed that the weight average diameter (MWD) of the 3 tests (water, ethanol, and rewetting) is higher for NT compared to CT. This shows that direct seeding has helped build good soil structure over time, which is highly desirable for improving agricultural productivity and conserving natural resources, especially water.
- Soils have slightly higher phosphorus and potassium contents at the surface (0-5 cm) in the NT compared to CT which is due to the fact that phosphorus is not very mobile and remains concentrated in the first cm after application of phosphate fertilization
- After 13 years of CA application at the Merchouch site, the NT was able to significantly improve the total nitrogen rate at the 0-5 cm horizon of the vertisol.



## Recommendation

### Based on these results, we would recommend:

- Extend this study, by carrying out several campaigns at different times of the year to fully understand the NT
- Agricultural policies reformulated to explicitly support conservation agriculture research and development
- Reason the fertilization under direct seeding and to take into account the fact of the accumulation of these elements in surface and the exports of crops

### Acknowledgements

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Thank you !

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