Original Research Article

Effects of the speed of mechanical tillage progression on iron soil structure

Running Title:Speed of mechanized tillage

ABSTRACT

The present work consists in evaluating the impacts of the plowing speed of three-body plows/discs hitched to a 60 HP tractor, on the structure of the ferralitic soil and determining the optimal speed in the Benin plateau, from 2019-2021. All plowing was carried out onthe same day on 21 plots, divided into 3 blocks of 7 elementary plots. The treatments areV0, V1, V2, V3, V4, V5, and V6, ie 2, 4, 6, 8, 10, and 12 km/h. V0 is a witness. The tests are carried out according to the standards: NF EN ISO 17892-4.2018, for the particle size analysis, NF EN ISO 17892.2018, for the Atterberg limits, NF P 94-050.1995, for the water content by weight, NF XP P 94 -047.1998, for the rate of organic matter, NF EN 1097-3.1998, for the apparent density. Soil conductivity is determined by the Muntz method (double rings). The results show that plowing at an average speed (6 km/h) generates a better content of water and organic matter which are respectively 5.04 ± 0.76% and 0.304 ± 0.004% for the ploughshare than(6. 47±0.35%; 0.324± 0.012%) for the disc plow. The higher content of water and organic matter generated by the average speed of 6 km/h would limit the risks of embrittlement while guaranteeing a conservative tendency of fertility. This work will allow agricultural tractor operators to better perform ferralitic tillage operations taking into account the

optimal plowing speed without seriously damaging the soil structure, a guarantee of sustainable development in agriculture.

***Keywords*:** Tillage, Struct-studies, Agriculture, Technical, Mechanical.

1. INTRODUCTION

Agriculture is significant in Benin due to its interdependencies with food, income production, education, health, and nutrition **(RNDG, 2015)**. Indeed, agriculture in Benin accounts for more than fifty percent of Gross Domestic Product (GDP), contributes eighty percent to the value of commerce, and gives more than fifty percent of raw materials to industry **(FAO, 2016)**. Therefore, agricultural production methods must be strengthened to feed the expanding global population. Therefore, the intensification of these systems entails a number of activities, including the introduction and use of agricultural machinery or equipment in order to satisfy the requirements of the world's population, therefore agricultural mechanization. This agricultural mechanization encompasses the use of tools and machinery for land reclamation, production, and post-harvest practices, powered by human, animal, or chemical internal combustion engines. It is a crucial agricultural product in sub-Saharan Africa with the potential to alter the lives and economic situations of millions of rural households **(FAO, 2019)** and enables farmers to earn a higher income **(Pussemier *et al*., 2017)**. In accordance with this reasoning, the Ministry of Agriculture has developed a strategic plan to revitalize the agricultural sector in order to transform Benin into an agricultural superpower and tackle food insecurity **(MAEP, 2019)**. This approach aims to increase production by mechanizing production variables, in particular the soil, which serves as the foundation for plant development. Because a well-structured soil permits plentiful root development and provides ample aeration, it is optimal for plant growth **(Feddal,**

2011). Indeed, tilling results in erosion, compaction, loss of organic matter, and restriction of water circulation**(Köller, 2003; Lal *et al*., 2007)**. It influences the biotic and abiotic elements of the soil, either directly by influencing the structural qualities of the soil, such as the arrangement of voids, aggregates, and the connectedness of the pores, or indirectly by modifying the soil's aeration, temperature, and permeability. Soil up to the roots **(Huwe, 2003)**. However, the farmer seeks ideal soil preparation that fulfils the needs of his crop often. According to **(Chehaibi *et al*., 2002)**, tillage may be maximized by selecting the appropriate width of the plow and forward speed. This last component is frequently overlooked while conducting cultural operations. According to **(Chehaibi *et al*., 2008)**, the pace of plowing has a significant effect on the soil's physical properties. Slow-speed tillage (2 km/h) produces a more structured volume of soil with a deeper depth of labour, resulting in a higher crop yield **(Chehaibi *et al*., 2008)**. It has also been demonstrated **(Damien, 2017)** that plowing at too high a pace (more than 10 km/h) can result in the placement of debris on top of the plow strips, so preventing the seeds from being buried deeply. Weeds. According to **(Seine *et al*., 2013)**, plowing at a speed of 4-5 km/h on loamy soil is advised in order to better preserve the structure of the plowing's heart. This demonstrates that the pace of plowing effects the soil structure. However, little research has been conducted on the optimal plowing speed for enhancing soil structure, germination, and crop production. The purpose of this study is to determine the influence of plowing speed on soil structure. It entails analysing the impacts of plowing speed on the physical characteristics of the soil, including grain size, water content, organic matter content, bulk density, porosity, and permeability. To achieve these varied goals, an experimental method was taken: the installation and description of the soil profile, the selection of the plowing depth, the selection of the various speeds, the selection of the experimental instrument, and the measurement of the soil's physical properties.

2.1. MATERIALS AND METHOD

2.1.1. Presentation of the study site

The study site **(Fig. 1)** is located in the Sudano-Guinean zone, towards the northern end of the Benin Plateau between latitudes 7°10 and 7°41' 17" North on the one hand and longitudes 2°24' 24" and 2°47'40" East on the other hand**(IGN, 2020).**

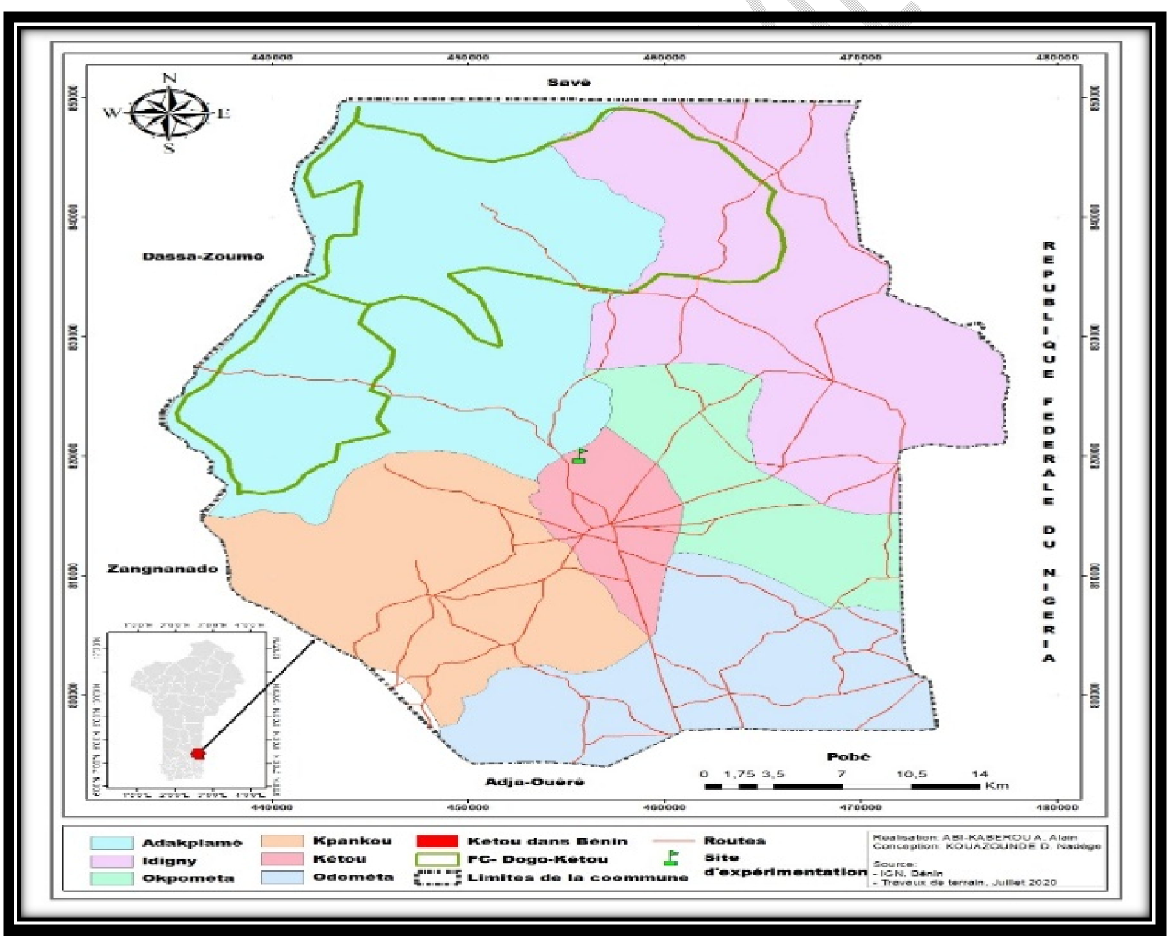


Fig. 1: Geographic location of the study site

Source: IGN 2020 (**National Institute of Geographic and Forest Information), Benin Plateau**

2.1.2. Description of the experimental protocol

The adopted experimental protocol is a complete random block with total randomization with 2 factors, random factor which is the block and fixed factor which is the speed of plowing. In this study, the main plot is (2124 m²) in area, inside this plot we have three blocks separated by (3 m) alleys to allow the passage of the tractor. Each block each contains seven elementary plots of (40 m²) in area separated by (3 m) alleys to allow the passage of the tractor. The **Fig. 2** below illustrates the experimental device adopted. Plowing is carried out with a 3-body ploughshare plow with a working width of (1.20m), hitched to a 60 HP agricultural tractor.

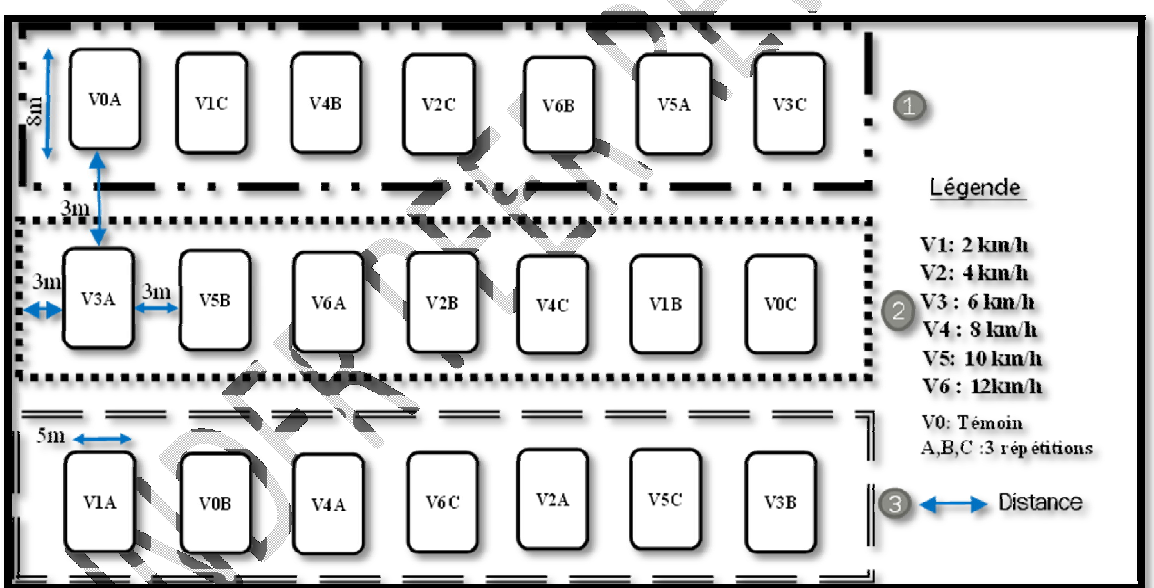


Figure 2: Diagram of the experimental device of the test: Complete random block (BAC)

Legend : V1 - Speed 2Km/h, V2 - Speed 4km/h, V3 - Speed 6km/h, V4 - Speed 8km/h, V5 - Speed 10km/h, V6 - Speed 12km/h, V0 - No speed, A, B, C - Repetition of treatments.

2.1.3. Sample Collection Methods

The cultural profile was analysed from the wall of a hole using the procedures of **(Delaunois, 2008)**. The cultural profile of (1.5 m wide, 2.0 long and 1.0 m deep) was installed to measure the depth of the topsoil. The observed topsoil depth is (25 cm), hence the retained plowing depth is (20 cm). Regarding the soil analysis tests (particle size analysis, Atterberg limits, and organic matter), reworked soil samples are collected using a manual auger at three sites along the diagonal of each plot, beginning at the ends and ending in the middle. These per-plot samples are combined in order to create representative samples per plot and subsequently per treatment. For the water content and bulk density measurements, samples are manually coring using a metal cylinder with a 100 mm diameter, 10 cm height, and a 20 cm depth. In addition, the two orifices of the cylinders are hermetically sealed to preserve the soil's humidity and density until the time of laboratory analysis.

Measurements made at ground level

- ***Particle size analyzes***

It was carried out up to (80 µm) by sieving the material by dry process (for large grains) or by wet process (for materials containing particles less than 0.063 mm) according to standard NF EN ISO 17892-4.2018.

- ***Atterberg limits***

The Atterberg limits conventionally translate the differences in behaviour of a soil according to its water content. They apply to the soil, the elements of which pass through a (400 µm) mesh sieve according to standard NF EN ISO 17892.2018. The Atterberg limits are determined using the plasticity index Ip which measures the range of water content in which the soil is found in the plastic state. It is determined by the following expression:

$$Ip = wl - wp \quad \textbf{(1)}$$

- *wl* represents the liquidity limit; - *wp* represents the plastic limit

- **Water content by weight (w)**

It represents the ratio of the mass of water evaporated during steaming (Mw) to the mass of solid grains (Md), obtained according to standard NF P 94-050.1995. The mass of solid grains is obtained after 4 hours of drying in the oven at (105°C). The water content by weight is expressed as a percentage and is determined by the following formula:

$$W = Mw/Md*100 \quad \textbf{(2)}$$

W: the water content by weight; Mw: mass of water; *Md*: the mass of solid grains.

- ***Organic matter content (OM)***

The test is carried out on particles with a diameter of less than (0.400 mm) according to standard NF XP P 94-047.1998. It is carried out using equipment consisting of a graduated cylinder, a tare, a Biomax solution, a stirrer, an oven and an electronic balance. The MO content is expressed as a percentage and is determined by the following formula:

$$MO = (Mi-MF)/Mi*100 \quad \textbf{(3)}$$

MO: Organic Matter; Mi: Initial mass before parboiling; *Mf*: Final mass after parboiling.

- ***Soil Bulk Density***

It is determined according to standard NF EN 1097-3.1998.

The formula for determining the bulk density of soil is given by the expression below:

$$Da = (P2-P1)/V \quad \textbf{(4)}$$

- $P2$: is the total weight of the sample; - $P1$: is the weight of the empty box; - V: is the volume of the box.

- ***Soil porosity***

It is conducted according to standard NF EN 1097-6.2001 and is determined by the following formula:

$$Porosity = 1-[[da]/((1+w)*ys)] \qquad \textbf{(5)}$$

With

da: apparent density; *w*: water content; *Ys*: actual density.

- ***Soil hydraulic conductivity***

The test consists of evaluating the evolution of vertical infiltration of a sheet of water under constant load into the ground over time. It is based on the müntz method principle **(Colombani *et al.*, 1972)**, commonly known as double müntz rings. It is derived using the formula:

$$Ks = Hi/tc \qquad \textbf{(6)}$$

Where *Hi* is the depth of infiltrated water and *Tc*, the cumulative duration.

2.1.4. Statistical analysis and data processing

All the statistical analyzes were carried out with the R software **(R Core Team, 2019)** and the level of significance of the statistical tests was set at 5%. First, we performed the correlation test between the physical properties of the soil in order to see the relationship between them. The analysis of variance made it possible to compare the influence of the plowing speed for each parameter evaluated. As for the other physical properties of the soil, the Kruskal-Wlalis comparison test was used. We performed Shapiro's normality test to decide whether to use parametric or nonparametric Kruskal

Walis analysis of variance when measurements are not normally distributed. The Student-Newman-Keuls tests were then carried out with the agricultural package from **(Mendiburu, 2019)** in order to structure the averages of these properties for the different plowing speeds. In the case of non-normality, the structuring of Kruskal Walis is carried out.

3. RESULTS

The results of the normality tests showed that only the data for water content (coulters and discs), porosity and organic matter discs are normally distributed. According to **Table 1**, the plowing speed significantly influences these aforementioned parameters ($P < 0.05$).

Table 1: Results of the analysis of variance.SD - standard error, DF - degree of freedom, Prob - probability, the averages followed by the same letters are not different by only 5%.

Speed (km/h)	**Property**	**Mean (SD)**	**F-value (DF=6)**	**prob**
0	Water content Socs (%)	5.23 (0.93)a	5.811	0.003
2		2.57 (0.46)b		
4		3.45 (0.12)ab		
6		5.04 (0.76)a		
8		4.89 (0.63)a		
10		4.54 (1.07)a		
12		4.16 (0.38)a		
0	Water content Discs (%)	5.05 (3.92)a	1.25	0.005
2		5.85 (4.72)a		
4		5.26 (4.14)a		
6		6.47 (5.35)a		
8		4.89 (3.77)a		
10		5.04 (3.92)a		
12		4.97 (3.84)a		
0	Soil porosity Discs (%)	0.458 (0.45)a	2.51	0.003
2		0.438 (0.43)a		
4		0.439 (0.43)a		

6		0.442 (0.43)a		
8		0.449 (0.44)a		
10		0.436 (0.42)a		
12		0.433 (0.42)a		
0	Organic Matter Discs (%)	0.437 (0.012)a	1.57	0.009
2		0.274 (0.012)a		
4		0.312 (0.012)a		
6		0.324 (0.012)a		
8		0.312 (0.012)a		
10		0.299 (0.012)a		
12		0.274 (0.012)a		

As shown in **Table 2**, the results of the Kruskall Wallis tests indicate that, for the soil plowed with these tools, negative correlation indicates that plowing at high speeds results in low levels of organic matter and reduced soil densities, whereas positive correlation indicates that plowing at high speeds results in the lowest plasticity indices and low levels of organic matter. Thus, via positive association, slow plowing yields the lowest indices of plasticity and organic matter for soils plowed with discs that have a high density; the soil plowed with ploughshares is rich in organic matter, has a low density, and a high plasticity index. However, 6 km/h provides the greatest results for water content, organic matter, indices, densities, and average porosity. In contrast to other speeds, six kilometres per hour defines the optimal physical ground conditions that result in superior performance.

Table 2: Kruskall Wallis test results. SD - standard error, χ^2- Chi-square statistic, DF - degree of freedom, Prob - probability, the averages followed by the same letters are not different by only 5%.

Speed (km/h)	Property	Mean (SD)	χ^2 (DF=6)	prob	Speed (km/h)	Property	Mean (SD)	χ^2 (DF=6)	prob

0	Organic matters Shares (%)	0.304 (0.004)a	17.09	0.008	**0**	Soil porosity (%)	0.458 (0.012)a	8.79	0.190
2		0.207 (0.003)ab			**2**		0.438 (0.006)a		
4		0.305 (0.002)a			**4**		0.439 (0.006)a		
6		0.304 (0.004)a			**6**		0.442 (0.009)a		
8		0.103 (0.003)b			**8**		0.449 (0.016)a		
10		0.105 (0.003)b			**10**		0.436 (0.006)a		
12		0.106 (0.003)b			**12**		0.433 (0.004)a		
0	Soil density(%)	1.346 (0.002)d	18.74	0.004	**0**	Plasticity index(%)	9.505 (0.003)ab	18.22	0.005
2		1.385 (0.005)bc			**2**		10.007 (0.003)a		
4		1.383 (0.003)c			**4**		9.007 (0.002)c		
6		1.357 (0.002) cds			**6**		10.003 (0.002)a		
8		1.395 (0.005)a			**8**		9.004 (0.004)c		
10		1.394 (0.002)ab			**10**		9.006 (0.003)c		
12		1.354 (0.004)d			**12**		9.001 (0.000)c		
0	Disc soil density (%)	1.405 (0.002)ab	178.15	0.001	**0**	Disc plasticity index (%)	10.1 (0.000)a	3.21	0.001
2		1.407 (0.001)a			**2**		9.1 (0.000)d		
4		1.398 (0.003)c			**4**		9.0 (0.000)e		
6		1.395 (0.001) cds			**6**		9.2 (0.000)c		
8		1.385 (0.001)e			**8**		9.3 (0.000)b		
10		1.394 (0.003)d			**10**		9.3 (0.000)b		
12		1.403 (0.0001)b			**12**		9.0 (0.000)e		

3.1. Particle size analysis

The **(Fig. 3)** below illustrates the plotted particle size analysis curves. It presents the percentage of passers-by as a function of the different sieve meshes at different plowing speeds with a ploughshare plow.

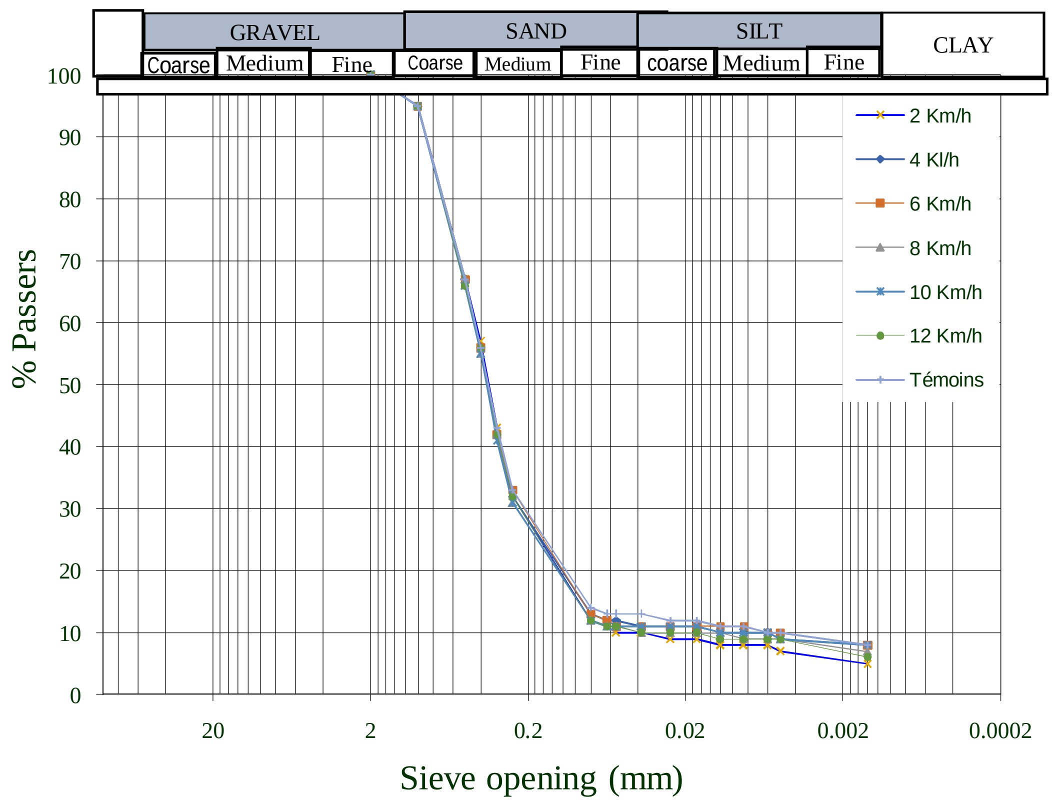


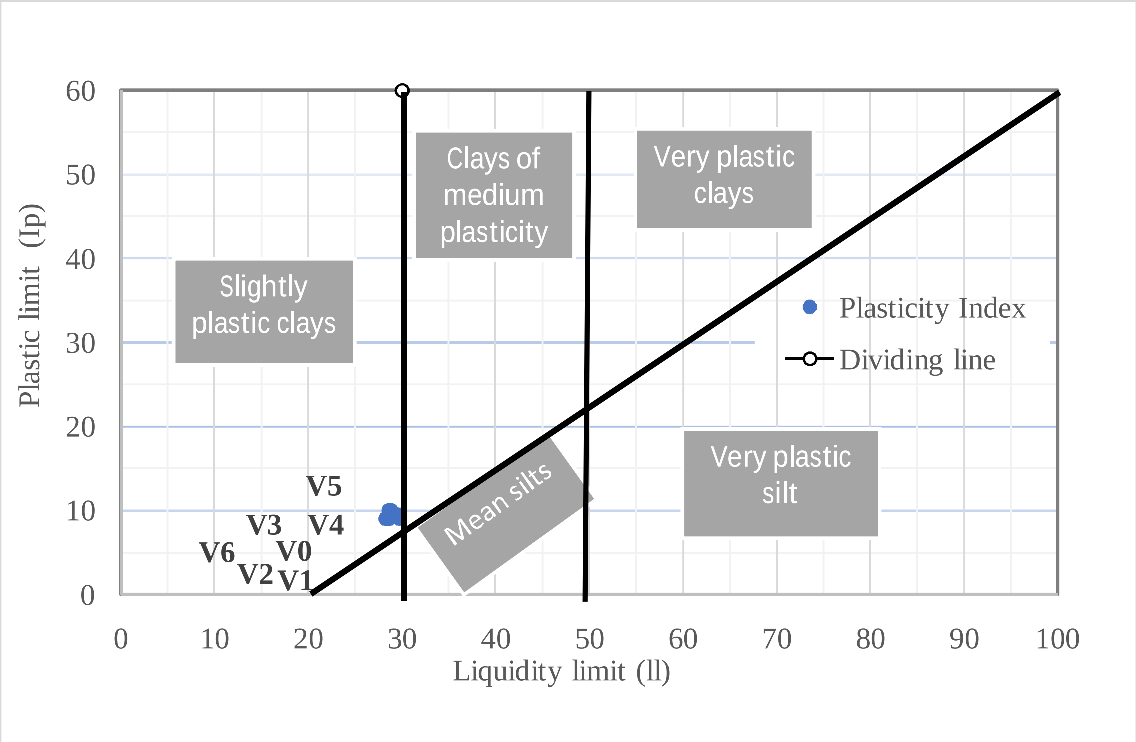
Figure 3: Particle size analysis curve of the different plowing speeds

Legend : V1 - Speed 2Km/h, V2 - Speed 4km/h, V3 - Speed 6km/h, V4 - Speed 8km/h, V5 - Speed 10km/h, V6 - Speed 12km/h, V0 - No speed, no plowing.

Plow share plowing therefore did not lead to a change in grain size. Thus, the plowing speed factor does not influence the grain size. Moreover, the particle size analysis does not make it possible to characterize the particles having sizes less than 80 µm (fine particles). Characterization tests on fine soils (the Atterberg limits) will certainly allow us to classify these particles.

3.2. Characterization of soils according to the Atterberg limits

The **(Fig. 4)** presents the different values obtained for the limits of liquidity and plasticity and which are represented in the plasticity diagram of Casagrande.



<u>Figure 4</u>: Liquidity and plasticity limits in the Casagrande plasticity diagram

Legend: V1 - Speed 2Km/h, V2 - Speed 4km/h, V3 - Speed 6km/h, V4 - Speed 8km/h, V5 - Speed 10km/h, V6 - Speed 12km/h, V0 - No speed, no plowing.

The plasticity diagram of Casagrande, allowed us to identify through these values, the various fine particles of passers-by resulting from the granulometric analysis of each parcel. Note that the fine particles of passers-by from V0 to V6 all belong to the class of less plastic clays.

Indeed, the plowing speed does not significantly influence the plasticity index at the (5%) threshold (**Table2**). Moreover, it is seen that the action of the tool (ploughshares and discs) on the ground, did not change the class of the fine particles of the ground, which confers on it the same character. Furthermore, the presence of clay soil with low plasticity at the level of plots V0 to V6, will make them impermeable and poorly ventilated and then form an obstacle to root penetration but with a good capacity to transport water by capillary action from the deep layers. Clay soil is an ideal seedbed for cotton because its surface is friable and has fine water-stable clods, which allowsquick and uniform emergence of seedlings (**Sharma *et al.*,2005**).

3.3. Evaluation of soil permeability

The **Fig. 5** below shows that the best permeability is obtained with the two tools at a speed of 6 km/h on ferritic soil. However, the soil worked by the ploughshare plow has a more permeable layer.

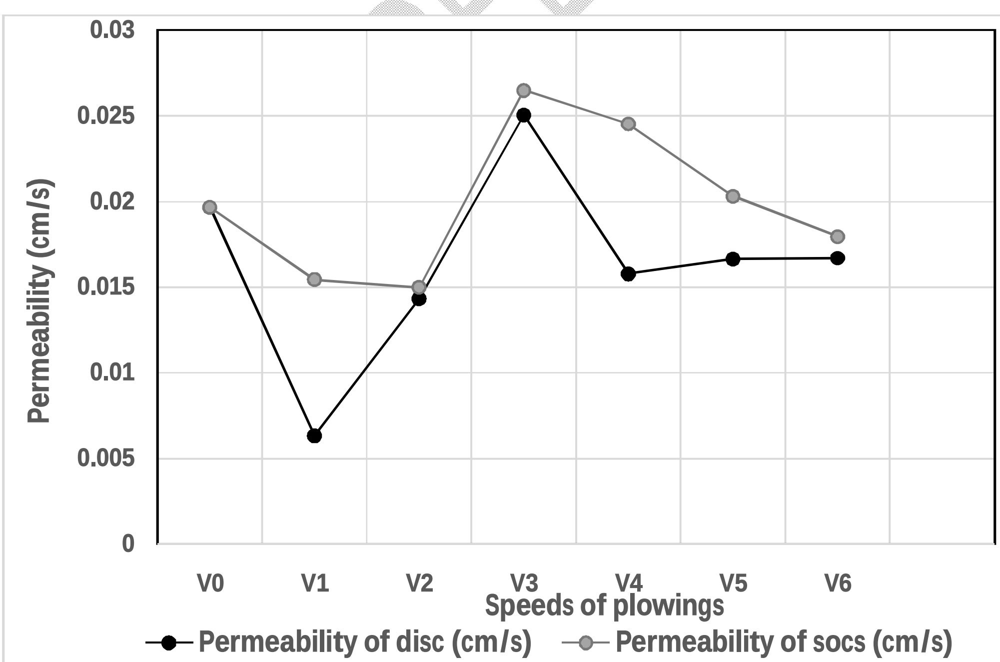


Figure 5: Permeability of plowed soil to coulters and discs as a function of plowing speed

Legend: V1 - Speed 2Km/h, V2 - Speed 4km/h, V3 - Speed 6km/h, V4 - Speed 8km/h, V5 - Speed 10km/h, V6 - Speed 12km/h, V0 - No speed, no plowing.

It can be seen that from V0 to V2, V3 to V6, the permeability is inversely proportional to the plowing speed. In addition, the maximum permeabilities are obtained at the level of V3 (6 km/h). Thus, the soil must be permeable especially at the level of the root zone and impermeable at the level of the basement in order to avoid too deep drainage. So, plowing at a speed of 6 km/h made it possible to obtain good soil permeability. We observe that at slow speeds, it is less, this is justified by the fact that the plowing by the plows has created fewer pores following a lesser dislocation of the earthen clods of the arable layer, giving enough difficulties to the water to cross them.

4. DISCUSSION

Optimal tillage speed results in marked improvement in soil physical properties, good root system extension, nutrient efficiency, and improved germination and productivity **(Nadjid, 2010)**. Low or high, plowing speeds reflect effects on the conservation of soil organic matter, humidity and water capillary capacity, and soil bulk density **(Jasim *et al.*, 2015; Mahmoudi, 2015)**. Indeed, there is a correlation between the characterization's parameters considered. Plowing at a slow (2 km/h) or fast (8 to 12 km/h) speed leads to a decrease in the water content of the soil, the porosity and the rate of organic matter and an increase in the apparent density of the soil and consequently lower yields with the ploughshare. Plowing at an average speed (6 km/h) leads to an increase in permeability, water content, organic matter content and soil porosity with a decrease in bulk density, thus leading to a better yield. The results proved that the granulometry of the ground does not change following the variation of the speeds but on the other hand, they apparently act on these characteristics. However, with **(Chehaibi *et al.*, 2008)**, having studied the effect of the forward speed of the tractor on the behavior of a loamy-sandy soil in the region of Chott-Mariem (Sousse) reveal that working at slow speed provides a much greater volume of plowed soil containing few voids at depth, therefore high compaction at depth, unlike high-speed tillage, which generates less compaction at depth with a reduced volume of soil worked. We see that there are fewer pores and a high density with the plow, hence a moderate infiltration rate, but with the disc plow, it is lower. We then note that the discs mix the soil much more and increase the fine particles, hence more voids. In addition, **(Jasim *et al.*, 2015)**evaluatedthe impact of tillage speed on the physical properties of clay-loam soil and maize yields and found that: operating speeds significantly affected soil bulk density and hydraulic conductivity values. As working speed increased, soil bulk density increased, and hydraulic conductivity decreased; and the best maize yield is obtained at the speed of (6 km/h) similar to our study. It therefore appears that the increase in the working speed generates an increase in the apparent density and a decrease in the conductivity of the soil. Thereby, working the soil at a medium speed can therefore lead to an increase in the hydraulic conductivity of the soil with a decrease in the bulk density and consequently a better yield. As a result, working at slow speed leads to a much larger volume of soil worked, leaving large aggregates containing many deep voids and consequently a reduction in energy consumption**(Keller, 2004; Zokpodo *et al.*, 2017)** without necessarily reducing crop yield. So, a good plowing at an average speed shows a better structured soil **(Zokpodo *et al.*, 2017)**. **(Jasim *et al.*,**

2015) evaluated the impact of plowing speed on the physical properties of clay-loam soil and maize yields. They revealed that: operating speeds significantly affected soil bulk density and hydraulic conductivity values. As working speed increased, soil bulk density increased, and hydraulic conductivity decreased; and the best maize yield is obtained at a speed of (6 km/h). It therefore appears that the increase in the working speed generates an increase in the apparent density and a decrease in the conductivity of the soil. Thus, working the soil at an average speed can therefore lead to an increase in the hydraulic conductivity of the soil with a decrease in the bulk density and consequently a better yield. Soil bulk density increased, and hydraulic conductivity decreased; and the best maize yield is obtained at a speed of (6 km/h). It therefore appears that the increase in the working speed generates an increase in the apparent density and a decrease in the conductivity of the soil. Thus, working the soil at an average speed can therefore lead to an increase in the hydraulic conductivity of the soil with a decrease in the bulk density and consequently a better yield. Soil bulk density increased, hydraulic conductivity decreased; and the best maize yield is obtained at a speed of (6 km/h). It, therefore, appears that the increase in the working speed generates an increase in the apparent density and a decrease in the conductivity of the soil. Thus, working the soil at an average speed can therefore lead to an increase in the hydraulic conductivity of the soil with a decrease in the bulk density and consequently a better yield.On the other hand, **(Al-Suhaibani*et al.*,2010)** evaluated the effect of plowing depth and speed using a moldboard plow on the quality of tillage of loamy-sandy soil.The depth and speed of plowing are therefore two determining factors in the quality of tillage. Thus, plowing at a speed of (5.5 km/h) for this author generates an improvement in the rate of soil inversion and a reduction in the weight average diameter of the clods with a plowing depth of (15-20 cm) thus leading to the improvement in the quality of tillage. On the other hand,**(Kadhim *etal.*,2012)**,showthat increasing the tillage speed to (7 km/h) causes a significant decrease in the weight diameter of the clods and in the total porosity. From all the above we see that the speed of tillage influences the structure of the soil in the sense that slowly it provides a better-structured soil with soil turning and greater working depth leading to a better yield. Quickly, it generates a reduced volume of worked soil associated with a reduction in the weight diameter of the clods of earth, the conductivity and the porosity of the soil with an increase in the apparent density of the soil. By 2030, the FAO envisages for states to minimize the costs associated with healthy and diversified production. To do this, it is necessary to encourage: the promotion of equipment systems adapted to the soil and good methods of driving agricultural machinery, the manufacture of simple machines for working the soil at a lower cost, increasing productivity through innovative techniques to ensure good sustainability while meeting the requirements of healthy, balanced nutrition of the poor population and environmental protection (**FAO, 2014**). Thus, the investigations have proven that reducing plowing to a minimum frequency and carrying it out at an optimal speed are necessary for mechanization which ensures optimum production and sustainable agriculture.Plowing, or the act of turning over the soil using a plow, can have a significant impact on the quality of tropical soils **(Olivares *et al.*, 2020; Olivares *et al.*, 2022a)**. One of the main effects of plowing is the destruction of soil structure, which can lead to increased erosion and reduced water retention capacity **(Olivares *et al.*, 2022b; Olivares, 2022; Olivares *et al.*, 2016)**. This can make the soil less fertile and less able to support plant growth.Another effect of plowing is the disruption of the soil's natural microbial communities **(Olivares *et al.*, 2021a; 2021b)**. These communities play a critical role in nutrient cycling and the overall health of the soil. Plowing can lead to a loss of these beneficial microorganisms, which can further decrease soil fertility **(Olivares *et al.*, 2022c)**.Additionally, plowing can also lead to the release of stored carbon, which can contribute to climate change**(Olivares *et al.*, 2019; Olivares and López, 2019)**. The destruction of soil organic matter through plowing can result in the release of large amounts of carbon dioxide and other greenhouse gases**(Olivares *et al.*, 2017; Olivares *et al.*, 2012)**. On the other hand, plowing can also have some positive effects on tropical soils. For example, it can help to control weeds and pests**(Bertorelli and Olivares, 2020; Olivares *et al.*, 2022d)**, and it can also aid in the incorporation of organic matter and other soil amendments.

Overall, the effects of plowing on tropical soils are complex and depend on a variety of factors, including the type of soil, the intensity and frequency of plowing, and the specific management practices used. Careful management and conservation practices can help to minimize the negative effects of plowing and maintain the quality of tropical soils.This is why it is necessary to control the driving of machines at an optimal speed to guarantee a well-structured and balanced soil, while limiting periodic plowing.

5. CONCLUSION

The results obtained show that the plow/disc plowing speed has an impact on soil physics. This research has made it possible to prove that plowing at a very slow or fast speed leads to a reduction in the water content of the soil, the porosity, the rate of organic matter, and consequently a drop in yields. Plowing with the plow on the ferralitic soil at an average speed of (6 km/h) generates on the other hand an increase in the rate of organic matter, the porosity, the water content, and the permeability with a decrease in the apparent density of the soil. Which will definitely lead to a good yield. Finally, we can conclude that in the agro-pedological and climatic conditions specific to our trial, working at a speed of 6 km/h guarantees good physical soil conditions leading to better cotton yield.

All this contributes to the mastery of appropriate farming mechanization techniques in thecontext of soil sustainability.

6. REFERENCES

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