# Effects of Land Use Change in the Hydrophysical Properties in Vertisols in Northeastern Mexico

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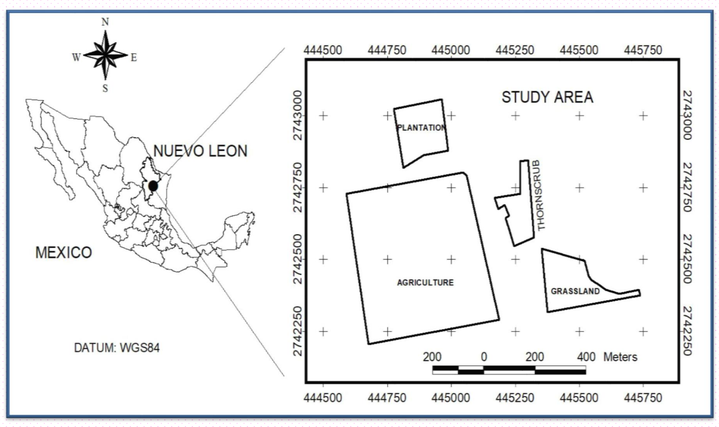
## INTRODUCTION

**The impact of the use of natural resources associated with anthropogenic activities has increased evidently, mainly through land use changes which have altered hydrophysical properties of soil**

**Hypothesis: In the same soil type (Vertisol), four types of land use system (grassland, agricultural, *Eucalyptus* plantation and thornscrub) and seasonal variation can modify the soil hydrophysical properties**

Keywords: Bulk density, hydraulic conductivity, infiltration, Land use systems, porosity, soil penetration resistance, Vertisol

## MATERIALS AND METHODS




- **Bulk density (*pb*)** (cylinder method)

$$pb\ (g\ cm^{-3}) = \frac{dry\ weight\ of\ sample\ (g)}{cylinder\ volume\ (cm^3)}$$

- **Total porosity (*φP*)** (Zhang et al., 2013)

$$\phi P\ (\%) = (1 - \frac{Bulk\ density\ (pb)}{2.65\ g\ cm^{-3}\ particle\ density})\ 100$$

- **Soil penetration resistance (*SPR*)**

*SPR* (*kg cm*$^{-2}$) Yamanaka soil hardness tester.

- **Hydraulic conductivity (*K*)** (falling head permeability test, Das, 2002, Sanchez, 2015)

$$K = \frac{3.46}{\Delta t}$$

Δt = t2-t1

- **Infiltration** (double ring infiltrometer)

Infiltration rate (*i,* mm hr$^{-1}$) nonlinear infiltration models of Kostiakov

Infiltration capacity (*fp,* mm h$^{-1}$) average infiltration rate for the last three measurement

cumulative infiltration (*fc*, mm) total water content infiltrated at 120 min

**Statistical analyses**

Shapiro-Wilk test and homogeneity of variances with Levene´s test

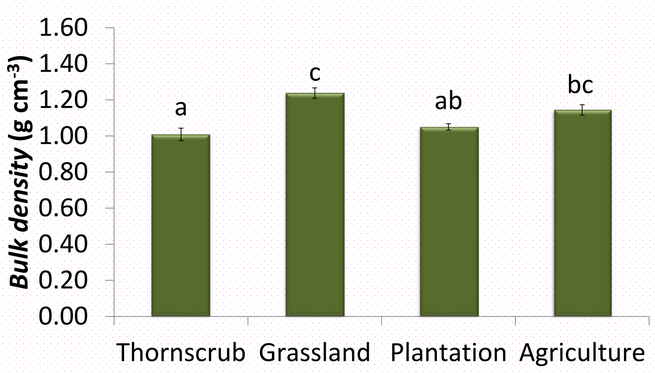
*Two-way analysis of variance (ANOVA): land use system (factor A) and seasonal changes (factor B) and mean comparison according Tukey´test*

## RESULTS

Results showed significant differences between land use systems and seasons for *K*, *fp*, and *fc*

| | Land use (FA) $F_{(3, 31)}$ | Season (FB) $F_{(3, 31)}$ | FA*FB $F_{(9, 31)}$ | Adjusted $R^2$ |
|---|---|---|---|---|
| *K* (cm s$^{-1}$) | 28.549** | 9.765** | 3.962** | 0.74 |
| *ρb* (g cm$^{-3}$) | 12.573** | 0.214$^{NS}$ | 0.994$^{NS}$ | 0.40 |
| *φP* (%) | 12.693** | 0.186$^{NS}$ | 0.989$^{NS}$ | 0.40 |
| *SPR* (kg cm$^{-2}$) | 54.445** | 0.564$^{NS}$ | 1.396$^{NS}$ | 0.77 |
| *fp* (mm hr$^{-1}$) | 38.092** | 3.643* | 2.985* | 0.74 |
| *fi* (mm hr$^{-1}$) | 21.046** | 2.549$^{NS}$ | 4.855** | 0.69 |
| *fc* (mm) | 23.845** | 3.308* | 3.390** | 0.67 |

*Notes.* FA: factor A; FB: factor B; *fc*: cumulative infiltration; *fi*: initial infiltration; *fp*: infiltration capacity; *K*: hydraulic conductivity; *SPR*: soil penetration resistance; *ρb*: bulk density; *φP*: porosity. *Significant differences ($p \leq 0.05$);** Highly significant differences ($p \leq 0.01$); $^{NS}$ No significant differences.



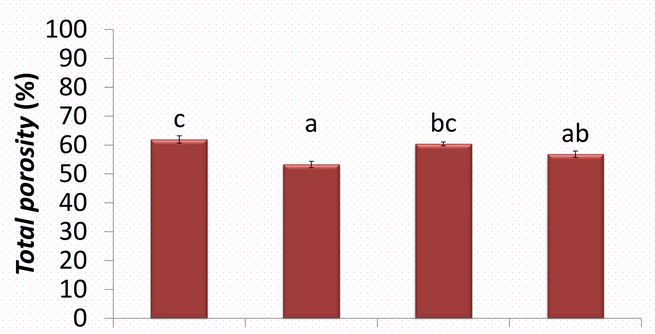
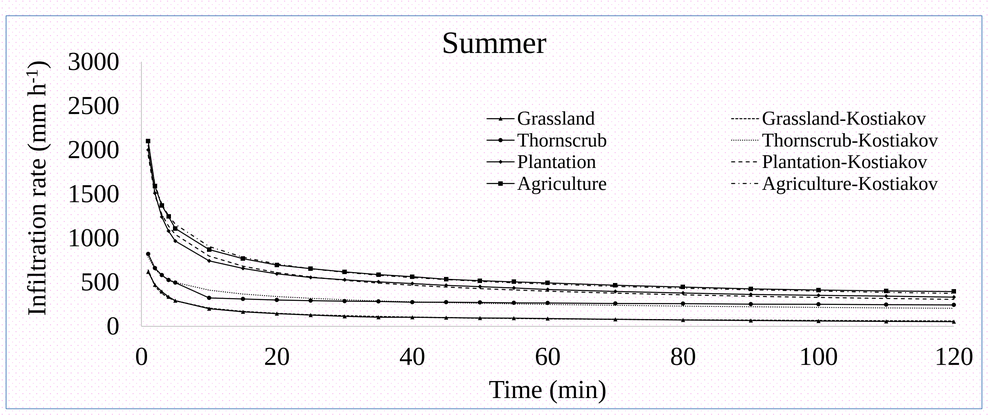
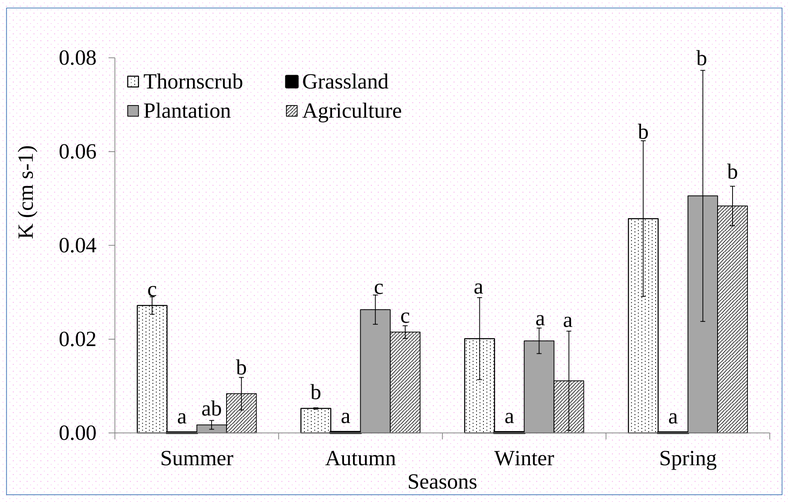



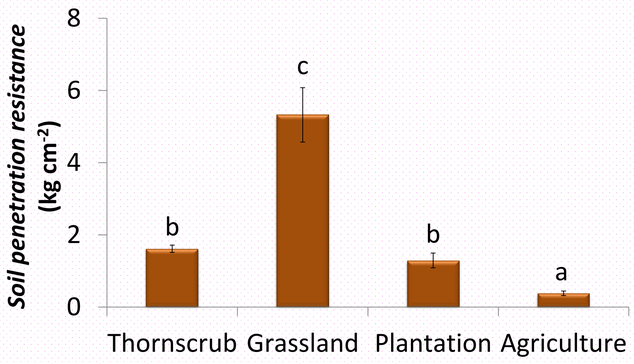

**TABLE** Mean values of infiltration capacity (*fp*) and cumulative infiltration (*fc*) at 120 min during infiltration tests for four land uses in each season of study. Different letter for *fp* or *fc* columns indicates a significant difference according to the Tukey's test ($p \leq 0.05$).

| | Summer | | Autumn | | Winter | | Spring | |
|---|---|---|---|---|---|---|---|---|
| Land use | *fp* (mm hr$^{-1}$) | *fc* (mm) | *fp* (mm hr$^{-1}$) | *fc* (mm) | *fp* (mm hr$^{-1}$) | *fc* (mm) | *fp* (mm hr$^{-1}$) | *fc* (mm) |
| Thornscrub | 229.3$^{ab}$ | 485.7$^{ab}$ | 192.2$^{b}$ | 416.7$^{a}$ | 246.4$^{b}$ | 576.0$^{ab}$ | 130.5$^{b}$ | 285.0$^{b}$ |
| Grassland | 65.7$^{a}$ | 105.3$^{a}$ | 54.0$^{a}$ | 107.3$^{a}$ | 53.6$^{a}$ | 105.0$^{a}$ | 46.9$^{a}$ | 119.0$^{a}$ |
| Plantation | 314.8$^{b}$ | 662.7$^{ab}$ | 192.7$^{ab}$ | 457.7$^{a}$ | 282.9$^{b}$ | 642.7$^{b}$ | 143.1$^{b}$ | 353.0$^{b}$ |
| Agriculture | 388.5$^{b}$ | 787.0$^{b}$ | 540.7$^{c}$ | 1061$^{b}$ | 190.6$^{ab}$ | 367.3$^{ab}$ | 285.0$^{c}$ | 528.7$^{c}$ |



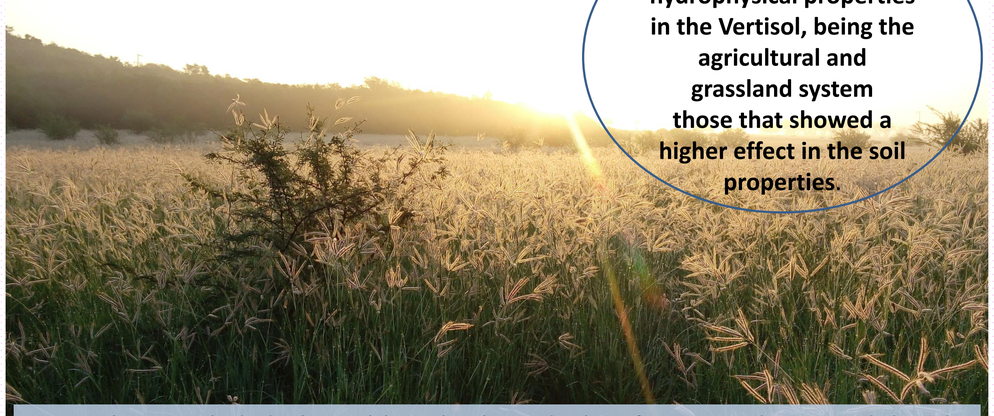




In the spring season, the values of *K* were higher, averaging up to 32.5% with respect to the other there seasons, except the grassland system which showed the lowest values during all seasons. In winter season, no differences were observed among land uses according to Tukey´s




For *pb*, *φP* and *SPR*, only were showed differences in factor A (land use). The correlation values of among *pb* and *φP* with other hydrophysical properties were significant except with SPR which did not show a significant correlation

## CONCLUSIONS



**Land use changes modified the hydrophysical properties in the Vertisol, being the agricultural and grassland system those that showed a higher effect in the soil properties.**

It can be concluded that although the edaphic factor is dominated by the characteristics of the interaction of factors at the time of its formation, the anthropogenic activities will determine the functioning of the soil system, contributing to changes that modify the physical properties, and affecting ecological stability and economic continuity.

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