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**The values of different types of acidity of pseudogley soils in the Kraljevo basin under forest, meadow and arable land uses**

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## Abstract

This paper presents the results of active (pH in $H_2O$), exchangeable (pH in KCl), hydrolytic (Y1) and total acidity (T-S) in humus–accumulative ($A_h$, $A_{hp}$) and subsurface ($E_g$, $B_{tg}$) horizons of Pseudogley Soils in Kraljevo Basin for 14 soil profiles excavated in forests, 16 in meadows and 24 on arable land. The results showed that acidification was weaker or more pronounced in all three most important tested horizons of Pseudogley Soils, and that the differences in the value of different forms of acidity existed among forest, meadow and arable land uses, as well as between the horizons of the same profile. The chemical reaction of soil solution ranged from very weak to extremely acid. The highest active acidity was found in forest profiles, especially in deeper horizons. Exchangeable acidity ranged from 3.7 to 4.9 pH units, with the forest profiles as the most acid, while the differences between meadow and arable land were less pronounced. The highest hydrolytic acidity was obtained in the forest profiles, while acidity in meadow and arable profiles was significantly lower and the lowest, respectively. Total acidity of the Kraljevo pseudogleys ranged from 6.2 to 24.8 meq/100 g soil and similarly to hydrolytic acidity, the value of total acidity was affected by the land use.

*Keywords*: different types of soil acidity, Pseudogley Soils, different land uses, Kraljevo basin

## Introduction

The group of the most widespread soil types in the lower altitude zone of Serbia. Pseudogley Pseudogley Soils are very common type of soils in Serbia, alongside Chernozems, Brown forest soils, Smonitza (Vertisols) and a group of alluvial plain soils (Fluvisols, Humofluvisols, Humogleys and Marsh black soils), and belongs to Soils in the Čačak-Kraljevo Basin are spread over approximately 32,000 ha and this basin is one of the most famous regions of their distribution in Serbia (Živković, 1970; Dugalić, 1998). In the Kraljevo Basin, Pseudogley Soils have been formed on the diluvial holocene terraces above the West Morava River and is tributaries, at the altitude between 180–290 m above sea level, mainly by pseudo-gleisation of leached soils, mostly on flat and gently sloping land (Živković, 1970). The geological substratum consists of multilayered, very clayey in deeper layers, compacted and very poorly water permeable sediments (Dugalić and Gajić, 2012). Agrophysical properties of Pseudogley Soils of the Kraljevo Basin can be characterised as unfavourable both in the surface $A_h$–horizon, and subsurface $E_g$ and in the deeper $B_{tg}$–horizon (Dugalić i Gajić, 2002). Although quite uneven, the chemical properties of Pseudogley Soils of this Basin are considerably unfavorable (Živković and Dugalić, 2001; Dugalić and Gajić, 2012). A low content of hums, acid chemical reaction, increased content of mobile aluminum, and poor supply of available phosphorus are the main properties of these soils (Krstić et al., 2012).

Since soil acidity is considered to be the most important factor that limits the plant growth on acid soils, the aim of this study was to compare different types of acidity of Pseudogley Soils under forest, meadow and arable land use, in humus and subsurface horizons, in order to better and more rationally propose chemical reclamation measures.

## Materials and Methods

### *Study area*

Soil samples for laboratory analysis were collected using the open pit method during 2001 (forest Pseudogley) and during 2012 (meadow and arable Pseudogley Soils). This method was applied in 10 villages, namely Jarčujak, Ratarsko imanje, Mrsać, Kovanluk, Drakčići, Ratina, Samaila, Bapsko polje, and Konarevo. Open test pits were selected so that a soil profile could be examined in its natural state, meaning the open pits uniformly represented different land/relief and vegetation conditions of Pseudogley Soils of the Kraljevo Basin. There were 54 open pits (14, 16 and 24 with forest, meadow and arable land, respectively) that were dug to a depth of 100 cm. Disturbed soil samples for laboratory analyses were collected from the depths of the humus or the ploughed horizons, while in subsurface horizons the samples were taken successively every 15-20 cm along the entire thickness of the soil profile.

### *Soil analysis*

The laboratory analyses encompassed the determination of active (pH in $H_2O$) and exchangeable (pH in KCl) soil acidity using the potentiometric method in a suspension with water and 1M KCl (1:2.5), while hydrolytic and total acidities were determined by the Kappen method (Kappen, 1929).

## Results and discussion

The acidity status of observed Pseudogley Soils of the Kraljevo Basin, in almost all analysed profiles , for all three most important horizons ($A_h$, $E_g$ and $B_{tg}$), showed poorer or stronger acidification. The exceptions are $A_{hp}$ and $E_g$–horizons of the profile number 2 from Ratarsko imanje - the experimental field of the Agricultural School, where calcification had been probably been used. Active acidity of the soils in the humus horizon (Table 1–3), with the exception of the profile in the experimental field in Ratarsko imanje, varied from 4.45–6.10, i.e. from the very weak to the extremely strong acid chemical reaction, most frequently between 4.7–5.0. A significantly narrow range of variation (pH in $H_2O$ between 4.78– 5.98) was observed in the humus horizon of Pseudogley Soils on meadows.

**Table 1**. The value of different types of acidity in Pseudogley Soils of the Kraljevo basin under forests

| Profile number | Depth (cm) | pH $H_2O$ | pH KCl | $Y_1$ ($cm^3$) | T-S (mEq/100 g) |
|---|---|---|---|---|---|
| | Forest profiles | | | | |
| 1 | 0-20 | 4.78 | 3.72 | 33.91 | 11.91 |
| | 20-40 | 4.82 | 3.82 | 18.45 | 8.69 |
| | 40-60 | 5.22 | 3.96 | 16.25 | 7.49 |
| | 60-80 | 5.62 | 4.24 | 12.42 | 6.08 |
| | 80-100 | 5.95 | 4.62 | 9.10 | 4.46 |
| 2 | 0-15 | 4.60 | 3.98 | 36.46 | 18.96 |
| | 15-35 | 4.80 | 3.86 | 20.71 | 9.75 |
| | 35-60 | 5.10 | 3.96 | 15.97 | 7.36 |
| | 60-80 | 5.38 | 4.10 | 12.68 | 6.21 |
| | 80-100 | 5.70 | 4.42 | 9.30 | 4.56 |
| 3 | 0-4 | 4.80 | 4.00 | 40.78 | 24.87 |
| | 5-20 | 4.53 | 3.61 | 31.44 | 14.00 |
| | 20-35 | 4.46 | 3.46 | 24.64 | 11.19 |
| | 40-60 | 5.00 | 3.56 | 24.84 | 12.23 |
| 4 | 0-10 | 4.45 | 3.67 | 47.90 | 21.68 |
| | 10-30 | 4.78 | 3.63 | 30.09 | 13.12 |
| | 30-50 | 4.84 | 3.64 | 23.58 | 10.43 |
| | 50-70 | 5.34 | 3.64 | 20.25 | 8.42 |
| 5 | 0-20 | 4.82 | 3.64 | 31.44 | 14.14 |
| | 20-35 | 4.93 | 3.61 | 25.73 | 11.43 |
| | 35-60 | 5.24 | 3.58 | 29.58 | 13.69 |
| | 60-80 | 5.35 | 3.60 | 26.03 | 11.93 |
| | 80-100 | 5.38 | 3.74 | 20.39 | 10.19 |
| 6 | 0-15 | 4.68 | 3.82 | 32.26 | 14.22 |
| | 15-35 | 4.80 | 3.64 | 28.73 | 11.51 |
| | 40-60 | 5.19 | 3.66 | 31.48 | 13.74 |
| 7 | 0-10 | 4.72 | 3.83 | 28.19 | 12.61 |
| | 10-20 | 4.66 | 3.64 | 36.95 | 14.34 |
| | 20-40 | 4.92 | 3.44 | 32.89 | 13.43 |
| | 40-60 | 5.01 | 3.46 | 24.36 | 10.00 |
| | 60-75 | 5.34 | 3.48 | 24.22 | 10.84 |
| 8 | 0-5 | 5.17 | 4.35 | 26.82 | 14.27 |
| | 5-25 | 4.72 | 3.61 | 30.90 | 13.52 |
| | 25-45 | 4.96 | 3.59 | 26.55 | 11.11 |
| | 45-65 | 5.24 | 3.70 | 19.90 | 8.99 |
| 9 | 0-10 | 5.03 | 4.09 | 33.67 | 17.83 |
| | 10-25 | 4.84 | 3.76 | 24.94 | 12.58 |
| | 25-40 | 5.06 | 3.71 | 20.80 | 10.38 |
| | 40-60 | 4.85 | 3.70 | 27.77 | 14.02 |
| 10 | 0-20 | 4.84 | 3.98 | 23.85 | 12.42 |
| | 20-40 | 5.10 | 3.69 | 21.14 | 9.49 |
| 11 | 0-5 | 5.26 | 4.42 | 32.57 | 16.48 |
| | 5-20 | 4.82 | 3.80 | 27.65 | 12.93 |
| | 20-30 | 4.96 | 3.60 | 23.81 | 10.86 |
| | 30-45 | 5.24 | 3.71 | 23.10 | 11.59 |
| 12 | 0-7 | 6.10 | 5.36 | 13.68 | 8.97 |
| | 7-15 | 5.13 | 4.03 | 20.87 | 11.02 |
| | 15-30 | 5.06 | 3.69 | 21.90 | 9.59 |
| | 30-45 | 5.07 | 3.60 | 28.15 | 12.61 |
| | 45-60 | 4.78 | 3.66 | 24.17 | 12.19 |
| 13 | 0-4 | 4.79 | 4.02 | 42.70 | 21.25 |
| | 4-20 | 4.56 | 3.51 | 39.57 | 15.94 |
| 14 | 0-10 | 4.83 | 3.87 | 23.31 | 12.39 |
| | 10-30 | 5.04 | 3.56 | 24.91 | 12.89 |
| | 30-45 | 5.07 | 3.47 | 25.91 | 18.04 |

**Table 2**. The value of different types of acidity in Pseudogley Soils of the Kraljevo basin under meadows

| Profile number | Depth (cm) | pH $H_2O$ | pH KCl | $Y_1$ ($cm^3$) | T-S (mEq/100 g) |
|---|---|---|---|---|---|
| | Meadow profiles | | | | |
| 1 | 0-15 | 5.40 | 4.38 | 18.32 | 10.08 |
| | 15-30 | 5.24 | 4.22 | 16.73 | 8.43 |
| | 30-50 | 5.34 | 4.16 | 15.25 | 7.68 |
| | 50-70 | 5.42 | 3.96 | 19.10 | 8.80 |
| | 70-100 | 5.62 | 4.24 | 13.97 | 6.44 |
| 2 | 0-15 | 5.98 | 5.38 | 11.00 | 6.05 |
| | 15-30 | 5.70 | 5.22 | 8.20 | 4.13 |
| | 30-50 | 5.30 | 4.12 | 18.23 | 8.97 |
| | 50-70 | 5.38 | 4.08 | 13.76 | 6.77 |
| | 70-100 | 5.56 | 4.42 | 10.78 | 5.28 |
| 3 | 0-15 | 5.03 | 4.01 | 22.23 | 12.04 |
| | 15-30 | 4.95 | 3.77 | 17.52 | 9.31 |
| | 30-45 | 5.15 | 3.76 | 18.61 | 9.67 |
| | 45-60 | 5.27 | 3.73 | 21.21 | 11.27 |
| | 60-80 | 5.46 | 3.90 | 16.18 | 8.41 |
| | 80-100 | 5.90 | - | 10.60 | 5.84 |
| 4 | 0-15 | 5.23 | 4.31 | 17.35 | 9.93 |
| | 15-35 | 5.30 | 4.04 | 15.72 | 8.42 |
| 5 | 0-15 | 5.70 | 4.77 | 14.64 | 8.77 |
| | 15-30 | 5.44 | 2.25 | 14.64 | 8.39 |
| | 30-45 | 5.44 | 3.97 | 14.51 | 8.64 |
| | 45-60 | 5.57 | 3.91 | 18.41 | 10.41 |
| | 60-80 | 5.72 | 4.02 | 17.18 | 8.98 |
| | 80-100 | 5.92 | - | 12.96 | 7.14 |
| 6 | 0-15 | 5.17 | 4.23 | 18.70 | 10.79 |
| | 15-35 | 4.80 | 3.74 | 18.43 | 8.80 |
| | 35-50 | 5.28 | 3.61 | 24.63 | 11.41 |
| | 50-70 | 5.63 | 3.67 | 22.32 | 10.89 |
| | 70-90 | 5.65 | 3.80 | 17.30 | 9.05 |
| 7 | 0-15 | 4.97 | 3.90 | 25.48 | 13.39 |
| | 15-30 | 5.22 | 3.73 | 22.44 | 10.70 |
| | 30-50 | 5.37 | 3.70 | 30.71 | 15.12 |
| 8 | 0-20 | 5.35 | 4.26 | 12.74 | 10.76 |
| | 20-40 | 5.47 | 4.00 | 16.26 | 9.07 |
| | 40-60 | 5.40 | 3.66 | 30.98 | 15.12 |
| 9 | 0-15 | 4.78 | 3.94 | 21.41 | 10.46 |
| | 15-30 | 4.87 | 3.69 | 24.36 | 10.92 |
| | 30-50 | 5.22 | 3.61 | 35.21 | 14.39 |
| | 50-70 | 5.37 | 3.70 | 26.76 | 10.87 |
| | 70-90 | 5.66 | 3.92 | 18.03 | 9.43 |
| | 90-110 | 5.74 | - | 13.35 | 7.35 |
| 10 | 0-15 | 5.24 | 4.18 | 19.52 | 10.54 |
| | 15-35 | 5.17 | 3.82 | 18.70 | 8.69 |
| | 35-50 | 5.53 | 3.71 | 27.21 | 12.24 |
| 11 | 0-15 | 5.62 | 4.50 | 16.80 | 9.26 |
| | 15-35 | 5.36 | 3.82 | 14.51 | 8.99 |
| 12 | 0-15 | 5.06 | 3.94 | 18.97 | 11.86 |
| | 15-30 | 5.00 | 3.62 | 22.44 | 11.63 |
| | 30-50 | 5.40 | 3.59 | 32.39 | 16.45 |
| 13 | 0-15 | 5.18 | 4.18 | 21.68 | 10.54 |
| | 10-25 | 5.26 | 3.87 | 21.35 | 10.22 |
| | 25-40 | 5.20 | 3.71 | 25.59 | 12.67 |
| | 40-60 | 5.23 | 3.74 | 23.03 | 11.54 |
| | 60-80 | 5.38 | 3.94 | 17.34 | 9.02 |
| | 80-100 | 6.02 | - | 10.24 | 5.64 |
| 14 | 0-15 | 5.27 | 4.22 | 20.25 | 10.97 |

| Profile number | Depth (cm) | pH $H_2O$ | pH KCl | $Y_1$ ($cm^3$) | T-S (mEq/100 g) |
|---|---|---|---|---|---|
| | | Meadow profiles | | | |
| | 15-30 | 5.20 | 3.78 | 20.80 | 10.43 |
| | 30-40 | 5.26 | 3.73 | 24.39 | 11.68 |
| | 40-60 | 5.27 | 3.72 | 25.59 | 12.16 |
| | 60-80 | 5.40 | 3.95 | 20.59 | 10.36 |
| | 80-100 | 5.65 | 4.34 | 15.64 | 8.60 |
| 15 | 0-10 | 5.07 | 4.28 | 19.24 | 11.30 |
| | 10-30 | 5.04 | 3.97 | 18.89 | 10.40 |
| | 35-50 | 5.17 | 3.70 | 26.48 | 12.72 |
| | 50-65 | 5.34 | 3.73 | 26.27 | 13.39 |
| | 65-80 | 5.50 | 3.94 | 22.01 | 11.00 |
| | 80-100 | 5.55 | 4.23 | 19.16 | 9.56 |
| 16 | 0-15 | 4.95 | 3.91 | 24.94 | 13.04 |
| | 15-35 | 4.96 | 3.74 | 22.99 | 11.30 |
| | 40-60 | 5.37 | 3.77 | 22.18 | 11.20 |
| | 60-80 | 5.68 | 4.05 | 14.90 | 8.78 |
| | 80-100 | 6.30 | - | 9.95 | 5.47 |

**Table 3**. The value of different types of acidity in Pseudogley Soils of the Kraljevo basin under arable land use

| Profile number | Depth (cm) | pH $H_2O$ | pH KCl | $Y_1$ ($cm^3$) | T-S (mEq/100 g) |
|---|---|---|---|---|---|
| | | Arable profiles | | | |
| 1 | 0-15 | 4.95 | 3.91 | 24.94 | 13.04 |
| | 15-35 | 4.96 | 3.74 | 22.99 | 11.30 |
| | 40-60 | 5.37 | 3.77 | 22.18 | 11.20 |
| | 60-80 | 5.68 | 4.05 | 14.90 | 8.78 |
| 2 | 0-20 | 6.84 | 6.10 | 1.25 | 0.81 |
| | 20-40 | 6.21 | 5.90 | 1.75 | 1.14 |
| | 40-60 | 5.68 | 4.50 | 10.36 | 5.02 |
| | 60-80 | 5.52 | 4.40 | 10.94 | 5.47 |
| | 80-100 | 5.94 | 4.82 | 7.62 | 3.73 |
| 3 | 0-15 | 4.55 | 3.74 | 30.36 | 15.10 |
| | 15-30 | 4.63 | 3.77 | 30.63 | 15.81 |
| | 30-45 | 4.68 | 3.58 | 22.77 | 8.78 |
| 4 | 0-20 | 5.44 | 4.41 | 17.62 | 9.82 |
| | 20-35 | 5.34 | 3.64 | 16.70 | 8.97 |
| 5 | 0-15 | 5.49 | 4.58 | 13.28 | 8.67 |
| | 15-30 | 5.13 | 3.80 | 19.43 | 10.70 |
| | 30-50 | 5.18 | 3.68 | 24.00 | 12.60 |
| 6 | 0-20 | 4.88 | 4.12 | 24.91 | 13.49 |
| | 20-40 | 5.07 | 3.90 | 17.58 | 9.57 |
| 7 | 0-20 | 5.05 | 4.16 | 18.43 | 9.82 |
| | 20-40 | 5.24 | 3.92 | 15.87 | 8.21 |
| | 40-60 | 5.65 | 3.76 | 22.98 | 11.57 |
| | 60-80 | 5.73 | 3.81 | 20.17 | 10.31 |
| | 80-100 | 6.14 | 4.00 | 14.54 | 7.99 |
| 8 | 0-20 | 5.50 | 4.52 | 17.89 | 10.92 |
| | 20-40 | 5.67 | 4.33 | 13.14 | 8.21 |
| | 40-55 | 5.60 | 4.16 | 15.49 | 9.98 |
| 9 | 0-20 | 5.36 | 4.34 | 17.08 | 9.69 |
| | 20-35 | 5.40 | 4.12 | 14.78 | 8.97 |
| | 35-55 | 5.63 | 4.17 | 12.83 | 8.40 |
| 10 | 0-20 | 5.42 | 4.42 | 14.36 | 9.47 |
| | 20-35 | 5.51 | 4.20 | 12.59 | 8.42 |
| | 35-55 | 5.57 | 4.04 | 15.49 | 10.23 |
| | 60-75 | 5.78 | 4.13 | 12.39 | 6.82 |
| 11 | 0-23 | 5.49 | 4.37 | 13.82 | 9.18 |

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| Profile number | Depth (cm) | pH $H_2O$ | pH KCl | $Y_1$ ($cm^3$) | T-S (mEq/100 g) |
|---|---|---|---|---|---|
| | | Arable profiles | | | |
| | 23-40 | 5.30 | 3.91 | 13.46 | 8.80 |
| | 40-60 | 5.70 | 3.77 | 23.03 | 13.03 |
| 12 | 0-20 | 4.87 | 4.23 | 16.80 | 13.37 |
| | 20-40 | 4.93 | 3.73 | 16.70 | 9.97 |
| | 40-60 | 5.30 | 3.70 | 26.20 | 14.55 |
| | 60-80 | 5.72 | 3.92 | 19.43 | 11.71 |
| 13 | 0-20 | 5.71 | 4.78 | 10.30 | 7.43 |
| | 20-40 | 5.17 | 3.90 | 15.87 | 9.21 |
| 14 | 0-15 | 5.30 | 4.46 | 13.28 | 9.20 |
| | 20-35 | 5.26 | 4.01 | 16.53 | 10.54 |
| | 35-55 | 5.27 | 3.73 | 27.41 | 15.43 |
| 15 | 0-20 | 5.34 | 4.29 | 16.53 | 10.08 |
| | 20-40 | 5.17 | 3.88 | 17.62 | 10.01 |
| | 40-60 | 5.24 | 3.67 | 30.25 | 14.55 |
| 16 | 0-22 | 5.08 | 4.29 | 15.99 | 10.89 |
| | 22-40 | 4.87 | 3.77 | 25.28 | 11.11 |
| | 40-60 | 5.00 | 3.70 | 26.51 | 12.82 |
| | 60-80 | 5.43 | 3.73 | 24.00 | 11.99 |
| 17 | 0-20 | 5.13 | 4.20 | 17.89 | 10.12 |
| | 20-40 | 4.54 | 3.64 | 21.14 | 9.95 |
| | 50-70 | 5.30 | 3.57 | 32.39 | 14.64 |
| 18 | 0-15 | 5.82 | 4.86 | 9.76 | 6.79 |
| | 15-35 | 4.97 | 3.67 | 17.62 | 9.44 |
| | 35-55 | 5.00 | 3.51 | 38.03 | 16.28 |
| 19 | 0-20 | 5.42 | 4.56 | 15.72 | 9.38 |
| | 20-40 | 5.74 | 4.56 | 10.95 | 7.66 |
| | 40-55 | 5.53 | 4.17 | 12.43 | 8.94 |
| | 55-70 | 5.66 | 4.16 | 12.28 | 7.98 |
| 20 | 0-15 | 5.21 | 4.25 | 17.89 | 11.40 |
| | 15-35 | 5.03 | 3.70 | 15.99 | 9.61 |
| | 35-50 | 5.22 | 3.56 | 30.42 | 15.53 |
| | 50-70 | 5.40 | 3.62 | 25.41 | 13.63 |
| 21 | 0-20 | 5.23 | 4.33 | 17.08 | 10.27 |
| | 20-40 | 4.98 | 3.78 | 18.97 | 9.56 |
| 22 | 0-20 | 5.46 | 4.22 | 14.36 | 8.59 |
| | 20-40 | 5.28 | 4.13 | 14.91 | 8.98 |
| | 40-60 | 5.42 | 3.75 | 21.58 | 12.43 |
| 23 | 0-20 | 5.27 | 4.32 | 16.80 | 10.40 |
| | 20-40 | 5.08 | 3.62 | 21.41 | 9.92 |
| | 50-70 | 5.30 | 3.60 | 30.14 | 14.89 |
| 24 | 0-20 | 5.11 | 4.17 | 18.70 | 11.72 |
| | 20-40 | 5.20 | 3.63 | 24.91 | 12.38 |
| | 40-60 | 5.15 | 3.59 | 28.45 | 14.11 |

The first subsurface, $E_g$–horizon, showed rather high active acidity that varied from pH 4.46 to 5.74. In this horizon, the highest acidity was recorded in forest profiles. On the other hand, meadow and arable profiles were quite similar, which is understandable because these soils were largely used alternately for field crops and meadows. Active acidity in observed Pseudogley Soils was, as a rule, high in the upper part of the $B_{tg}$–horizon, which usually started at a depth of 40–50 cm, less often at a much greater depth. According to data presented in Tables 1–3, pH in $H_2O$ at the depths of 30–40 and 50–80 cm varied from 4.8 to 5.7 in 43 examined profiles. The highest active acidity in the $B_{tg}$–horizon was recorded in forest profiles of Pseudogley Soils. These data testifies that roots of forest trees, mainly oaks, significantly affect acidification

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of deeper parts of the soil profile, both by absorbing great amounts of base elements by plants, and by excreting large amounts of $CO_2$ and various organic acids, especially tannins, which are mostly found in oak forests (Blume et al., 2016). Oak forests prevail in the forest vegetation on Pseudogley Soils of the Kraljevo Basin. There is no doubt that a significant part of tannic and other organic acids, among which fulvic acids dominate, reach the surface part of the $B_{tg}$–horizon of forest Pseudogley Soils by leaching from surface horizons, and due to poor water permeability of the $B_{tg}$–horizon increases active and especially potential acidity in the soil. This is evidenced by strong increase in exchangeable acidity and the content of easy mobile Al–ions in the stated horizon (Đalović et al., 2012).

Increased exchangeable acidity is characteristic for soils in which acidification processes are very pronounced. Therefore, the reaction of the soil solution became quite acidic, with the pH values < 5.0, which is, as already stated, a distinctive property of Pseudogley Soils in the Kraljevo Basin, particularly in their $A_h$, $E_g$ and the upper part of the $B_{tg}$–horizon, down to the depth of 60–80 cm, frequently even deeper. As presented in Table 1–3, exchangeable acidity (pH in KCl) in the humus horizon varied from 3.7 to 4.9. In the $E_g$–horizon, exchangeable acidity increased, except in the profile in the experimental field. The highest exchangeable acidity in the $E_g$–horizon was recorded in the forest profile, while this acidity was the highest in approximately 2/3 of observed profiles in the $B_{tg}$–horizon, as previously determined by Dugalić et al. (2019).

In addition to high active and exchangeable acidity, Pseudogley Soils of the Kraljevo Basin are also characterised by high values of hydrolytic and total acidity not only in eluvial but also in illuvial horizons. The highest hydrolytic acidity, both in the Ah horizon and the $E_g$ and $B_{tg}$–horizons, was recorded in the forest profile of Pseudogleys, which is in agreement with studies carried out by Čakmak et al. (2009), who found that about 71% of extremely acid soils were covered by forest and meadow vegetation. The meadow profiles of Pseudogley Soils had lower hydrolytic acidity than forest profiles in $A_h$ and $E_g$–horizons, while the difference in hydrolytic acidity between forest and meadow profiles in the $B_{tg}$–horizons was insignificant. Values of hydrolytic acidity in arable profiles in the $A_h$–horizon were lower than in meadow, and especially forest profiles. These data showed that the conversion of forest Pseudogley Soils into arable lands significantly reduced hydrolytic acidity in the $A_h$, i.e. $A_{hp}$–horizon, but also in the $E_g$–horizon. Observed by $Y_1$ values, meadow Pseudogley Soils ranked between forest and arable soils, although they were much closer to arable soils, which can be explained by the fact that the majority of today's Pseudogley Soils had been occasionally used as arable lands.

Total acidity of Pseudogley Soils in the Kraljevo Basin is quite high. It ranged from 6.2 to 24.8, 6.9 to 15.9 and from 6.2 to 18.0 mEq/100 g soil in $A_h$, $E_g$ and $B_{tg}$–horizons, respectively (Table 1–3). Similarly to hydrolytic acidity, effects of the methods of Pseudogley Soils utilization reflected upon the value of total acidity.

## Conclusion

Acid conditions were more or less pronounced in the three most important horizons ($A_h$, $E_g$, $B_{tg}$) in observed Pseudogley soils in the Kraljevo Basin under forest, meadow and arable land use. The highest active and exchangeable acidity was determined in forest profiles in all observed horizons. The difference between meadow and arable land Pseudogley Soils in the values of their active and exchangeable acidity was less pronounced. In addition to high active and exchangeable acidity, Pseudogley Soils of the Kraljevo Basin were characterised by high values of hydrolytic and total acidity, not only in eluvial but also in illuvial horizons. The highest hydrolytic acidity, both in the $A_h$–horizon, and the $E_g$ and $B_{tg}$–horizons, was observed in forest profiles of Pseudogley Soils. Meadow profiles have lower hydrolytic acidity compared with forest profiles in the $A_h$ and $E_g$–horizons, while differences in values of hydrolytic acidity in the $B_{tg}$–horizon between forest and meadow profiles were insignificant. Total acidity of Pseudogley Soils of the Kraljevo Basin was high and ranged from 6.2 to 24.8 meq/100 g soil, and similarly to hydrolytic acidity, the effect of the land use reflected upon the value of total acidity.

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# Vrednosti različitih tipova kiselosti pseudogleja u Kraljevačkoj kotlini pod šumom, livadom i oranicama

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## Izvod

U ovom radu su predstavljene vrednosti aktivne (pH u vodi), izmenljive (pH u KCl-u), hidrolitičke ($Y_1$) i ukupne kiselosti (T-S) u humusnom horizontu ($A_h$, $A_{hp}$) i potpovršinskim ($E_g$, $B_{tg}$) horizontima pseudogleja, na 14 lokacija u šumi, 16 na livadama, i 24 na obradivim površinama u Kraljevačkoj kotlini. Rezultati su pokazali da je zakišeljavanje slabije ili izraženije u sva tri najvažnija ispitana horizonta pseudoglejnih zemljišta, te da postoje razlike u vrednostima različitih oblika kiselosti u šumama, livadama i njivama, kao i među različitim horizontima pseudoglejnih zemljišta. Hemijska reakcija zemljišnog rastvora se kreće od vrlo slabe do izrazito kisele. Najveću aktivnu kiselost imaju šumski profili, posebno oni u dubljim horizontima. Izmenljiva kiselost se kretala u rasponu od 3,7 do 4,9 pH jedinica, pri čemu su šumski profili bili najkiseliji, dok su razlike između livadskih i njivskih profila bile manje izražene. Najveća hidrolitička kiselost zabeležena je u šumskim profilima, dok je kiselost u livadskim i njivskim profilima značajno niža, odnosno najniža. Ukupna kiselost pseudogleja Kraljevačke kotline kretala se od 6,2 do 24,8 meq/100 g zemljišta, a slično kao i hidrolitička kiselost, na vrednost ukupne kiselosti uticao je način korišćenja zemljišta.

*Ključne reči*: različiti tipovi kiselosti, pseudoglej, različiti načini korišćenja, Kraljevačka kotlina

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