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THE POSSIBILITIES OF INTENSIVE FIELD CROP PRODUCTION ON THE PSEUDOGLEY TYPE OF SOIL USING THE COMPLEX AMELIORATION MEASURES

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Abstract: In Republic of Serbia the pseudogley type of soil outspreads on approximately 443.000 ha or 4,7 % of the total area. At the area of West and North-West Serbia this type of soil outspreads on approximately 360.000 ha or 20% of the total area. The main characteristics of Pseudogley are unfavorable chemical properties, heavy mechanical composition, compaction and low hydraulic conductivity, which result in an unregulated water-air regime. An ameliorative action that could regulate unfavorable water regime of these soil types is the implementation of the horizontal pipe drainage. On experimental drainage field Varna near Šabac, owned by Institute of Soil Science, on the pseudogley type of soil, it was established an experiment in order to follow the effect of different spaces of the horizontal pipe drainage on increase of the yields of main crops (wheat and maize) in relation to the undrained areas. The processing of data of the realized yields in the period 2004-2009 shows that on the plots on which the pipe drainage was implemented, compared to the undrained areas, the yield of wheat increased 8-60%, while the yield maize increased 6-43%. Regarding the areas at which this type of soil outspreads, by implementation of the complex amelioration measures this potentially productive soil would enable economically profitable agricultural production, especially crops for animal food. This will increase the opportunity for intensifying animal production.

Key words: pseudogley, amelioration, horizontal pipe drainage, crop production

Introduction

The investigation was conducted at experimental drainage field of the Institute of soil science, Varna, (44°41′38″; 19°39′10″) located on the tenth

kilometer road which leads from Šabac, southeast to Loznica and Valjevo, at the entrance to the village Varna *(Pivić, 2005)*.

The site belongs to the area of Mačva, which represents the western extension of Srem depression. The terrain is mostly flat, but with expressed micro relief.

The area belongs to the crop-vegetable agricultural region that is characterized by milder form of moderate - continental climate *(Milosavljevic, 1980)*. For the entire area it was identified processes of seasonal over moisten soil.

The experimental filed Varna was established on pseudogley type of soil characterized by adverse chemical, physical and water-air properties, and requires the implementation of complex ameliorative techniques.

Previous studies of the experimental field site indicate the occurrence of long-term over-moisture, which affects the limited conditions of access and removal of excess water, especially in the spring period *(Dušić and Rudić, 1985)*.

The yields of wheat and maize on the plots of experimental drainage field Varna were observed during period from 2003.- 2009. During this period yields were measured and calculated for control plot and for the plot with drainage pipes with spacing of 20, 25 and 30 m. Results were analyzed and commented.

Regarding the areas at which this type of soil outspreads, by implementation of the complex amelioration measures this potentially productive soil would enable economically profitable agricultural production, especially crops for animal food. This will increase the opportunity for intensifying animal production.

Materials and Methods

The experimental field Varna *(Piperski, 1990),* was established in 1950, in order to monitor the effects of fertilization on pseudogley soils. From the day of its establishment, on the soil of the mentioned experimental field the wheat and maize were grown in crop rotation system and used for human and animal nutrition.

In 1978 the main project of the drainage of a part of sample plot was constructed (project engineers: Ćurković B., Sladoje B.).

Figure 1. shows layout of set horizontal pipe drainage.

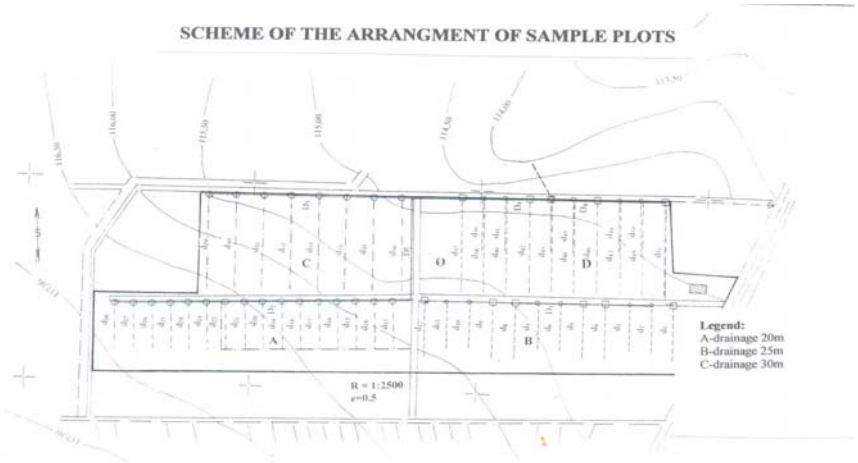

Figure 1. Layout of horizontal pipe drainage

Drainage sample plot consists of four separate parts of rectangular form, separated by a road for mechanization. On plots B and D drainage was implemented with drain spacing of 25 m, using flexible perforated PVC drainage pipes ∅80mm, at the depth of 0.95m. Drain length is equal to plot length and amounts to 52 m, minimal design slope is 0.25%.

During June 2002, it was performed the reconstruction of existing drainage and established new drainage on the new part of experimental field (project engineers: Prof.dr. Rudić D., dr Pivić R.), by adding two additional variants of drain spacing treatments: 20m (field A) and 30m (field C), at the same depth of 90 cm, and perforated PVC pipes Ø80mm.

For processing the climatic data of the observed location it was used the data for basic climatic elements from nearest meteorological stations: Sabac, Varna, Loznica and Valjevo (for the period 1964-2009), obtained from Republic Hydro meteorological Bureau. The values of the main climate elements are presented in the Table 1.

Table 1. Mean monthly value of meteorological data (1964 -2009)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	$\bar{x}$
Air tempe-rature (°C)	0.1	2.5	6.8	11.8	17.2	20.3	22.0	21.4	16.9	11.8	6.1	1.7	**11.5**
Relative air humidity (%)	87.0	84.0	77.0	74.0	74.0	77.0	76.0	77.0	81.0	84.0	86.0	89.0	**80.0**
Precipitation (mm)	44.5	50.1	54.4	58.7	64.1	86.8	75.0	59.7	57.8	59.4	63.7	62.6	**61.4**
Insolation (%)	65.1	91.7	143.3	177.7	231.6	252.0	298.8	269.9	199.5	151.3	82.9	53.2	**168.1**
Cloudiness (0-10)	7.2	6.7	6.2	6.2	5.7	5.3	4.2	4.1	5.1	5.6	6.9	7.5	**5.9**

The investigated areas, drained and undrained, are in the experimental field and the same standard agro-technical measures were applied. The mentioned crops, wheat and maize, were grown continuously in crop rotation system during the analyzed period of experiment.

Yields were calculated using volume method. The data on the yield obtained present the values adjusted to 14% moisture content.

The analysis of collected data was presented in tables and in combined graphics with precipitations and yields for the period of observation. All collected data was elaborate with statistical methods.

Results and Discussion

First results about the effects of horizontal pipe drainage application for increasing the yields, were published in the papers of *Mc Call (1928), Kallbrunner (1930), Bertram (1931), Fauser (1937), Schulte-Karring (1970), Levaković (1976), Tomić (1976), Plamenac (1986), Rujević (1986), Molnar et al. (1988, 2002), Petošić et al. (2003).*

Kurucz (1997) published the data on the effects of the different ameliorative actions applied, which indicate that, by applying the pipe drainage, the increase in yield in grain units per hectare was up to 28.6%.

About the yields on the variants with and without drainage, *Plamenac (1976, 1977, 1980)* has reported in the studies carried out in experimental drainage field Nelindvor. The average index of increase in maize yield for the follow-up period of 8 years is 200%, and for wheat over the 9 years of registering the realized yields - 138.5%, compared to the control without drainage.

During the long-term research of the natural conditions and climatic parameters in the areas of study it was found the frequent display of an excessive soil moisture in spring (March-May), summer (July and August) and autumn (October-November). This water regime has extremely adverse effects on the soil moisture status during the tillage, sowing and harvest.

For the follow-up period (2003-2009), the average values of the maize and wheat yields from all the tested variants with horizontal pipe drainage were determined for using for evaluation of the production and economic effects of implemented measures.

Table 2 presents data on the yields of both crops, in conditions of an undrained area, and of the variants where the horizontal pipe drainage was done (20, 25, 30 m).

In the experiment the yields of crops on the drainage variants were determined in three replications. The yields per years are given in $t \cdot ha^{-1}$. Table 2. shows yields during the observation period.

Table 2. Yield on the sample plot Varna

Year	Culture	Average yield (t·ha^{-1})				Increasing of yields (%)			
		Control	Drainage spacing 20 m	Drainage spacing 25 m	Drainage spacing	Control	Drainage spacing 20 m	Drainage spacing 25 m	Drainage spacing
2003	Maize	2.65	3.60	3.53	3.51	100	137	133	132
2004	Wheat	3.90	4.24	4.23	4.21	100	109	108	108
2005	Maize	3.80	5.15	5.11	5.00	100	135	135	132
2006	Wheat	2.07	3.32	3.15	3.19	100	160	152	154
2007	Maize	2.34	2.93	2.61	2.48	100	125	111	106
2008	Wheat	3.92	4.20	4.18	4.12	100	107	107	105
2009	Maize	2.52	3.99	3.70	3.65	100	158	147	145

Variation of yields during the period of observation have presented trend. The factors which have main impact on variation were insufficient resources and assets for normal implementation of agro technical measures during the period of observation.

Figure 2., presents yields of wheat and precipitation in hydrological year and in the vegetation season for control plot and for the plot with drainage pipes with spacing of 20,25,30 m.

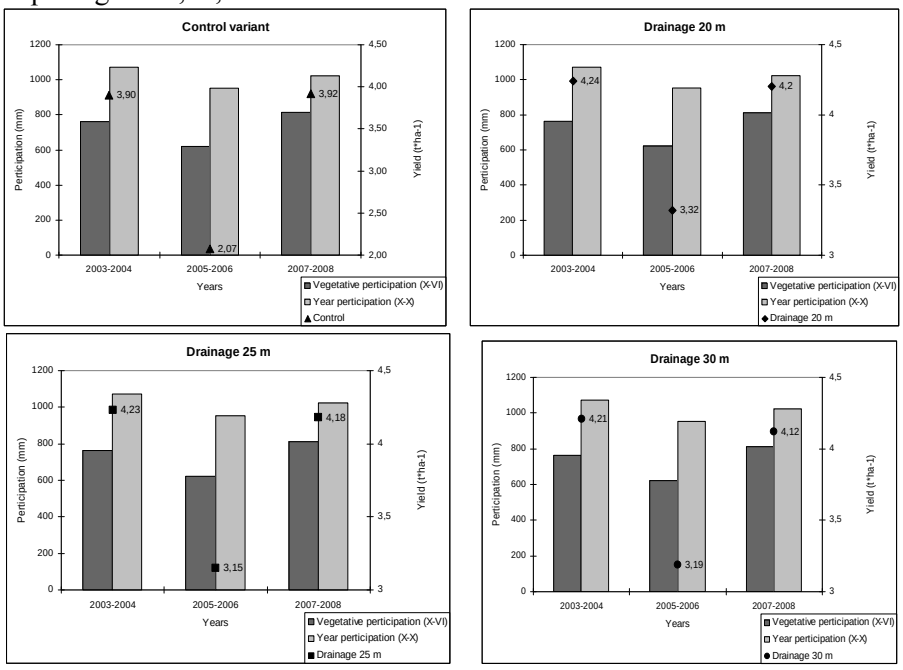

Figure 2. Yields of wheat and registered precipitation on control plot and plot with drainage

Figure 3. presents yields of maize and precipitation in summer, vegetation and annual period of observation for control plot and for the plot with drainage pipes with spacing of 20,25,30 m.

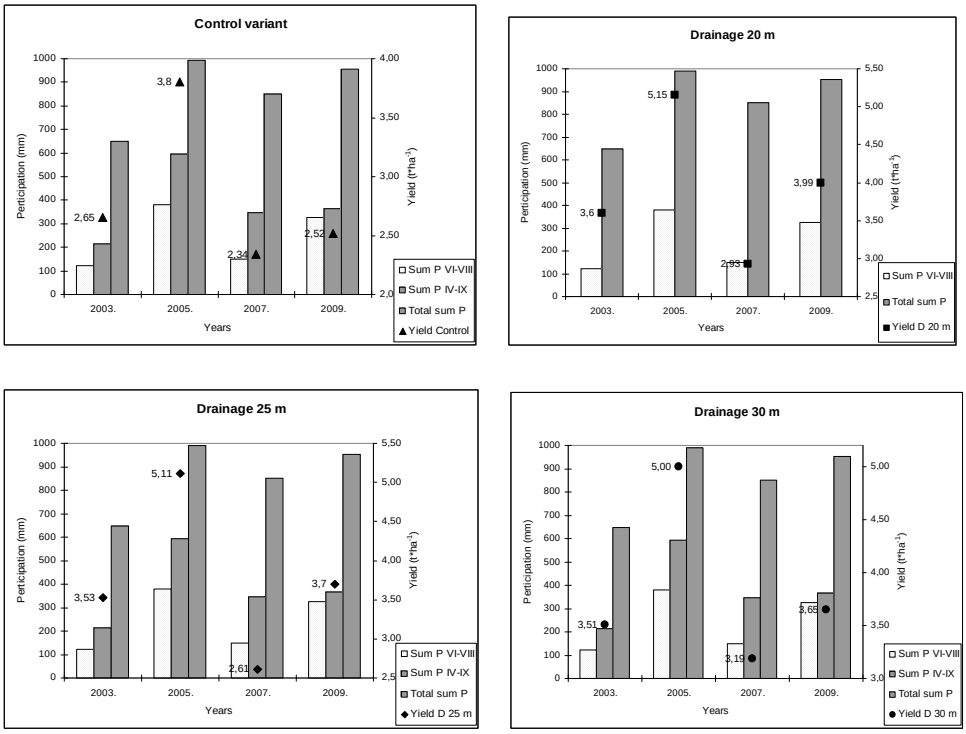

Figure 3. Yields of maize and registered precipitation on control plot and plot with drainage

Conclusion

By monitoring the data on soil moisture, it was found that the sowing could be made 10-15 days earlier in the plots where the horizontal pipe drainage was done, which supports the quality and quantity of the realized yields.

Analysis of the results obtained indicates that the realized yields of wheat and maize in the drained areas are significantly higher than the yield registered in the undrained (control) variant.

Given the investment in setting up the drainage and economic gains achieved by increasing the yields per unit of area, for this type of soil the drainage, placed at a distance of 30 m, gives satisfactory application parameters.

Yields in the period 2003-2009, show that on the plots where drainage was implemented, increase in average yield of wheat was registered from 8-60%, depending on seed material, type of implemented agro-technical measures and productiveness of the year, comparing the plots without drainage – control plots. Increase in average yields of maize during observation period, comparing the plots with drainage and control plots, was 6-43%, depending on same facts as for wheat.

Obtained results show that implementation of pipe drainage on pseudogley soils is one of the measures that can result in rising economic results in intensive agricultural production on soils with limited fertility.

The constructed system has enabled the positive effects even in the first years of exploitation, since the sowing might be performed in optimal time, unlike the adjacent plots, on which it was not impossible to done it due the soil over-moisture.

Regarding the areas at which this type of soil outspreads, by implementation of the complex amelioration measures this potentially productive soil would enable economically profitable agricultural production, especially crops for animal food. This will increase the opportunity for intensifying animal production.

Mogućnosti intenziviranja ratarske proizvodnje na zemljištu tipa pseudoglej primenom kompleksnih meliorativnih mera

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Rezime

Zastupljenost pseudogleja na području Republike Srbije je oko 443.000 ha ili oko 4,7% površine. Na području zapadne i severozapadne Srbije ovaj tip zemljišta zauzima oko 360.000 ha ili oko 20% od ukupne površine.

Osnovne karakteristike pseudogleja su nepovoljne hemijske osobine, težak mehanički sastav, zbijenost i mala hidraulička provodljivost, odnosno neregulisan vodno-vazdušni režim. Jedan od meliorativnih postupaka kojim je moguće regulisati nepovoljni vodni režim ovih zemljišta je izvodjenje horizontalne cevne drenaže.

Na oglednom drenažnom polju Instituta za zemljište, Varna kod Šapca, na zemljištu tipa pseudoglej, vršena su istraživanja uticaja različitih rastojanja horizontalne cevne drenaže na povećanje prinosa osnovnih ratarskih kultura pšenice i kukuruza u odnosu na nedrenirane površine.

Obrada podataka o ostvarenim prinosima u periodu 2004-2009. godina, pokazuje da je na parcelama na kojima je izvedena cevna drenaža zabeleženo

povećanje prinosa pšenice u iznosu 8-60%, odnosno 6-43% povećanja prinosa kukuruza u odnosu na nedrenirane površine.

S obzirom na površine koje zauzima, ovo potencijalno plodno zemljište bi uz primenu kompleksnih meliorativnih mera, omogućilo ekonomski rentabilnu poljoprivrednu proizvodnju naročito ratarskih kultura koje se koriste za stočnu ishranu. Time bi se uticalo i na intenziviranje stočarske proizvodnje.

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