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Particle Size Distribution as a Basic Characteristic for Pedotransfer Prediction of Permanent Wilting Point

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The permanent wilting point (PWP) belongs to the basic soil hydrological constants and plays the important role in an estimation of the natural or irrigating moisture availability to agricultural plants. Direct measurement of hydrological parameters demands significant amount of time, efforts and equipment. Pedotransfer functions (PTF) can provide an alternative way to an estimation of these parameters indirectly, by calculation, using accessible parameters of the basic soil properties in soil databases. **Aim**. To work out new PTF for an estimation of permanent wilting point in the chernozem soils of Ukraine. **Methods**. For the purpose of PTF working out, the multivariate linear regression equations have been applied. Data from the Ukrainian Soil Database are used for calibration of models sample included 239 data sets of permanent wilting point and particle size distribution (PSD) values obtained by direct measurement in the top genetic horizon of both typical and ordinary chernozems. Independently, 59 data sets have been used for verification of models. **Results**. The best model among several considered has been recognized that one, where the contents' parameters of three grain size fractions (according to N. A. Kachinskyi's classification) – 0.01−0.005, 0.005−0.001 and < 0.001 mm (%) – have been identified as the essential independent variables. Thus, accuracy of the forecast ($R^2 = 0.64$) is quite admissible. **Conclusions**. Forecasting of permanent wilting point by construction of the pedotransfer function including three fractions of particles is tangibly possible, considering availability of PSD data in a soil database.

Key words: particle size distribution, pedotransfer function, permanent wilting point, chernozem.

INTRODUCTION

The permanent wilting point (PWP) characteristics i.e., the soil moisture, when the plants experience the essential deficiency in the water that causes irreversible (steady) wilting of them, are of great significance for calculating of both the range of actual moisture and irrigation rate for watering, or for moisture provision determining various soils. PWP is one of the key hydrological parameters of soil affecting its physical and agricultural quality, as the minimal content rate of the moisture available for plants. Therefore, multifunctional soil databases must necessarily contain the data of the kind. The pedotransfer functions (PTF) is the proper technique for closing the gaps in the existing databases as it has already been approved by many researchers. It means forecasting by calculating the indices almost unavailable for measurement or analysis by means of other benchmarks, which variables are easily measured or available. The replacement of this very kind is called pedotransfer, while the mathematic formula for calculation – correspondingly, PTF [1, 2]. As the PTF ground breaker J. Bouma [3] said, “PTF converts the currently available data into the ones we need”.

The soil PWP is that very hydrological characteristic, which connection to the particle size distribution of soil was one of the first revealed regular connections promoted the development of entire trend in the science and, in particular, pedotransfer simulation.

The first attempt to use a method of plants' PWP predicting through the particle size distribution, following McBratny *et al*. [1], has been made in the explorations of Briggs and McLane (1907), and later – in researches of Briggs and Shantz (1912). They have defined the wilting point coefficient as the function of the percentage in the soil of three groups of the particle size distribution's fractions – sand (0.05−2.0 mm), silt (0.005−0.05 mm) and clay (< 0.005 mm).

In one of the contemporary explorations of Stirk [4] performed in Australia PWP for the soils with the portion of clay up to 60 per cent is proposed to be calculated using the following equation: PWP = 0.4 clay (*clay* in the Australian classification corresponds to the particles of < 0.002 mm). It means, the author forecasts the most important hydrological characteristic of the Australian soils using only the data about content of only one fraction.

A permanent deficiency in reliable comparable and compatible measured data for the complex determinant models concerning the quality of soil makes the pedotransfer approach the most realistic method of obtaining the solid information from the soil databases up to these days. At that, the contemporary researchers have to select and to compare various methods among the set of mathematic tools for the pedotransfer simulation. The multivariate linear regression equation together with artificial neural networks are most frequently used in the explorations dedicated to the forecasting of soil hydrological characteristics, as follows from the plenty of published surveys and results of experiments [1, 5–8].

Both the validation of regression approach in our previous studies and recently published favorable reports concerning its forecast efficiency as for the soil hydrological characteristics prompted us to take the multivariate linear regression equation as the variant of PTF.

The aim of the current exploration was to build PTF for calculating of the permanent wilting point parameters in the typical and ordinary chernozems. The practical effect of the present research is the contribution to closing gaps in the Ukrainian Soil Database used for evaluating the quality of soils [10].

MATERIALS AND METHODS

The pedotransfer models based on the multivariate linear regression equation first of all include the soil properties that correlate in pairs, what is proven by calculations for the specific ranges (limits) of their parameters. In other words, in order to determine the PTF input indices – independent variables, or predictors, it is necessary to obtain the information about the influence of each of them individually on the predicted index – the dependent variable, or predictant. For that very purpose the pair binding is revealed in the initial stage. Many researchers use exactly this method for the preliminary selection of the forecasted model's components [7]. At that, the fact that the coefficients of pair correlation between the predictor and predictant cannot be lower than the difference between various predictors included in one and the same model is taken as an axiom. Specifically, this sign was considered as a priority argument for pair binding's estimation and independent variables' selection.

Further, in keeping with the highest correlation coefficients, the predictors were selected and data sets were prepared. The method of the data set preparation is based on the need for distinct identification of soil standard identification units – type, subtype, kind, lithologic series (parent material and its texture), form and variety (soil texture). The quality control of a data set is a thorough critical analysis of the data by an expert together with the determination of variability.

PTF has been built on the basis of the multivariate linear regression equation using the STATISTICA, v. 6 software for the models' construction and analysis. The data sets were prepared applying the MS Excel software, whereto the data from the Ukrainian Soil Database (DBMS as a VisualFoxPro file) converted [9].

Models' testing or, verification has been made on an independent data set never involved in the master data set for the model calibration by means of comparing the calculated parameters to the ones experimentally measured through the correlation coefficients. The root-mean square error and coefficient of determination served as the basic criteria of the model "adequacy", what was consistently approved in researches of various scholars [6, 7, 10−12].

RESULTS AND DISCUSSIONS

Stage One – Predictors' Choice. The hydrological properties of soil are known to be determined by particle size distribution together with content of humus and exchangeable cations (at least, calcium), first of all, *i. e.* by the factors causing porosity, degree of aggregation, and correspondingly, interrelation between the solid and liquid phases of soil. Thus, for the purpose of missing data calculation as for PWP – the *predictant* of the future model, it is necessary to select from the database the information about the *predictors* – the content of all texture fractions, humus and exchangeable calcium.

Almost each of 2030 profiles within the Ukrainian Soil Database is provided with the information about the content of all seven texture fractions in accordance with the method of determination by N. A. Kachinskyi. Each fraction is considered as the separate independent variable, whose content, in its natural essence, never depends on the content of the rest of fractions. The physical clay parameters (total particles less than 0.01 mm) was not included into the data set traditionally used for the description of soils, since the its rate is dependent on the content of two silt fractions (0.01−0.005 and 0.005−0.001 mm) and clay fraction (< 0.001 mm). Furthermore, two sand fractions were not included into the research: the large one (> 1 mm), which is practically never met in the soils of Ukraine, and medium-size (1−0.25 mm), which is very rarely reported in the chernozems (typical and ordinary) selected as the study objects.

While taking into account all above mentioned prerequisites for finalizing of the pedotransfer simulation's methodological features, the first soils' data set was created out of the typical chernozems, whereto typical and ordinary on loess subtypes, except for medium- and high-eroded, were included. This set involved the data on all above enumerated predictors within the top-first genetic horizon. The objects involved into the data set almost completely encompass the entire territory of the chernozems' expansion. However, there are more information concerning the chernozems of the left-bank wooded-steppe and steppe provinces of Ukraine (Table 1).

The statistical parameters of the general data set created for the substantiation of the predictors' choice are represented in Table 2. The greatest portion of information relates to the soils particle size distribution – 611 patterns, while the least part − to the content of exchangeable-absorbed calcium – 130, at that PWP is known for 298 patterns. Even from this very table it follows that PWP forecasting based upon the sufficiently available data on content of the particle size distribution fractions is quite reasonable.

For the final choice of the predictors the correlation ratio of dependent PTF components to the independent ones was determined with the aid of the pair correlation. It is known that the use of pair correlation coefficients for determining the correlation ratio can be considered as reasonable, if sampling multitude corresponds to the completely randomized (not determined) model, *i. e*., when both variables are random values [13]. In other words, the pair correlation coefficients between the predictors cannot be higher than the ones between the predictors and predictant.

Table 3 depicts the simple pair correlation coefficients between all criteria probably influencing on the PWP parameters forming.

The first line of Table 3 contains the pair correlation coefficients between PWP and each of the possible predictors, while the rest ones – the coefficients reflecting the correlation ratio of one predictors to the other.

On the assumption of the stated correlation coefficients, PWP is closely connected to the content of clay (0.79), and both the large dust and little sand fractions – this very connection is reverse and with the smaller correlation coefficients (−0.53 and −0.49). The connection is considerably weaker with the content of exchangeable calcium and humus. In previous studies some regularities as for the close connection between hydrological constants and the soils texture were reported. Thus, the connection between PWP with the content of physical clay and clay is acknowledged as the most essential [14].

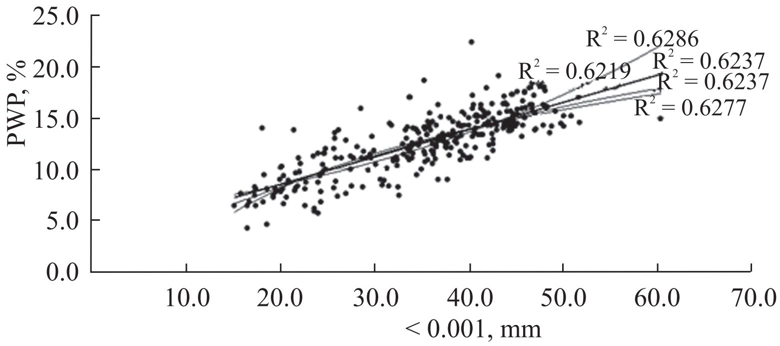
Further on, the predictors connected to PWP closer than to each other should be selected. These are three fractions of particle size distribution (0.01–0.005, 0.005–0.001 and < 0.001), and partially, Ca^{2+} and humus (Table 3 with the mark "*"). So, in theory, all these criteria can be used in the PWP simulation with the aid of the multivariate linear regression equation. Extremely low coefficients of the correlation between PWP and the content of humus and exchangeable calcium with due regard to an insufficient amount of available data cause some doubts since before the beginning of the models building. However, taking into account the special role of these criteria in the forming of the moisture capacity of soil, it has been decided not to exclude them from the multitude of the predictors at this very stage.

Stage Two – Choice of Functional Relationship's Type. The choice of the functional connection type between the predictant and predictors is extremely important. This is shown as the reflection of the pair connections between PWP and content of the clay fraction (< 0.001 mm) in the form of the dot diagrams (Figure). It is considered reasonable to draw several trends [15] for

Table 1. Geographical Aspects of the Chernozems' (Typical and Ordinary) Data Set

NAZ* Zone	NAZ Province	NAZ District	Administrative Region	Points
Polissia	Western	Malo-Polissia	Lviv	3
	Left-bank	Chernihiv-Polissia	Chernihiv	7
Wooded-Steppe	Western	Opolskyi	Ternopil	3
	Right-bank	Middle-Dnieper-Buh	Vinnytsia, Kyiv, Kirovohrad, Khmelnytskyi, Cherkassy,	18
		Dnieper	Kirovohrad, Cherkassy	3
		Volyn-Podillia	Odessa	4
	Left-bank	Middle-Dnieper-Seym	Cherkassy, Poltava, Kyiv, Sumy, Chernihiv	21
		Vorskla-Sula	Poltava, Sumy, Chernihiv	68
		Kharkiv-Oskol	Kharkiv	148
Steppe	Danube Delta	Transnistrian	Odessa	8
	Right-bank	Southern Buh-Inhul	Dnipropetrovsk, Kirovohrad, Mykolayiv, Odessa	25
	Left-bank	Donets	Donetsk, Luhansk	68
		Donets-Dnieper	Donetsk, Dnipropetrovsk, Zaporizhzhia, Kharkiv	117
		Oskol-Aydar	Donetsk, Luhansk, Kharkiv	101
Arid Steppe	Danube Delta	Danube-Dniester	Odessa	5
	Right-bank	Dniester-Lower-Dnieper	Dnipropetrovsk, Kherson	3
	Left-bank	Dnieper-Azov	Zaporizhzhia	7

*NAZ – Natural-Agricultural Zoning of Ukraine.



Power wilting point (PWP) connection to the clay content (< 0.001 mm) in the typical and ordinary chernozems (n = 298) (See the above text for further detailed explanations)

the choice as the basis for the forecast of that one among them, for which the determination coefficient R^2 will be maximal. The figure shows unessential differences in the form of the graphs of linear (R^2 = 0.623), logarithmic (R^2 = 0,621), polynomial (R^2 = 0.623), power (R^2 = 0.627) and exponential (R^2 = 0.628) connections of PWP to the clay content. The similar pattern was observed on the graphic mappings of PWP connections to other particle size fractions.

The visual identity of the graphs and determination coefficients allows to state that the linear form of the data approximation can be completely reliable. And this is not a singularity. The comparison between the linear and quadratic equations in the researches of the Iranian scholars [16] performed using the light texture soils reported that the saturated hydraulic conductivity of soils is better evaluated with the usage of the linear equation.

Stage Three – PWP Simulation. Models' Calibration and Expert Evaluation. Having analyzed the influence of all predictors used in the calculations, it was concluded that all texture fractions obviously take the first place in the power of influence on soil PWP (Table 3). The final choice of the model's components should be performed with due regard to the recommendations of Minasny, McBratney *et al*. [1, 6], who formulated two basic principles relative to construction or selection of finished PTF: the first one concerns *efficiency* (ef-

Table 2. General Data Set Statistics (For Predictors' Choice Substantiation)

Criterion	*n*	Parameter			Std
		Minimal	Maximal	Medium	
PWP, %	298	4.2	22.3	12.5	3.01
0.25−0,05 mm, %	611	0.0	56.4	9.8	8.26
0.05−0.01 mm, %	611	1.0	69.7	33.2	11.22
0.01−0.005 mm, %	611	1.7	26.3	9.8	3.81
0.005−0.001 mm, %	611	1.4	31.0	11.3	3.94
< 0.001 mm, %	611	11.6	60.5	34.6	9.85
(Ca+2), meq/100 g of soil	130	7.0	54.7	33.4	9.91
Total humus, %	305	1.59	10.05	5.12	1.32

Table 3. Pair Correlation Coefficients Between Permanent Wilting Point (PWP) and Chernozems' Properties

Criterion	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001	Ca^{2+}	Humus
B3	–0.49	–0.53	0.36	0.60	0.79	0.32	0.23
0.25-0.05		–0.19	–0.32	–0.44	–0.51	–0.11	–0.25*
0.05-0.01	–0.19		–0.41	–0.47	–0.64	–0.33*	–0.18
0.01-0.005	–0.32	–0.41		0.27	0.33	0.09	0.24*
0.005-0.001	–0.44	–0.47	0.27		0.51	–0.07	0.03
< 0.001	–0.51*	–0.64*	0.33	0.51		0.28	0.17
Ca^{2+}	–0.11	–0.33	0.09	–0.07	0.28		0.66*
Humus	–0.25	–0.18	0.24	0.03	0.17	0.66*	

*The inter-criteria correlation value exceeds the value of correlation between a criterion and PWP.

forts dedicated to the measurement of the predictors' parameters must be considerably less ones concerning the predictants), and second touches upon *precision* (if there are several functions, use that, which causes the least number of errors and is created on the basis of the soils most related to yours).

Thus, taking the above into account, for the PWP forecasting several multivariate linear regression equations were formulated in order to have an opportunity to estimate both their efficiency and precision before the final choice.

Equation 1:

$y = 5.88–0.05 \cdot x_1 – 0.03 \cdot x_2 + 0.04 \cdot x_3 + 0.17 \cdot x_4 + + 0.17 \cdot x_5$;

$F\,(5, 233) = 105.47$; $p < 0.0000$; $N = 239$.

Predictant: y – permanent wilting point (PWP) of plants;

Predictors: x_1–x_5 – particle size distribution fractions' content (x_1 – 0.25–0.05; x_2 – 0.05–0.01; x_3 – 0.01–0.005; x_4 – 0.005–0.001; x_5 – < 0.001 mm, %).

Expert Evaluation of the Model. The value of the multiple regression coefficient (R = 0.83) gives evidences on the close joint connection between the predictors and predictant in the multivariate linear regression equation. The determination coefficient is the parametric characteristic of successful variable, *i. e.* it reflects the portion of the predictant's variation connected to the parameters of predictors. In the 1st model $R^2 = 0.69$ and it means the variation of the soil water capacity within the PWP limits depends on a change in the content of the particle size distribution fractions for 69 per cent that points out the acceptability of model for the forecasting (since determination is above 50 per cent).

Further on, significance and adequacy of the model were evaluated – since after checking, if the revealed connection between predictant and complex of the predictors has the random nature. For this means the Fisher's ratio test (F-test), *t*-criterion and *p* level of significance (p-level) were used as the basic indices.

In Equation 1 *F* has an extremely high value ($F(5.233) = 105.47$ (F critical = 4.39)), and also, p-level is highest ($p < 0.0000$) in terms of large number of data ($N = 239$). This proves the fact that the created regression is of high significance in whole. However, the level of the significance of each predictor within the limits of model is subject to checking.

The results of each predictor's evaluating (x_1-x_5) are represented in the functional part of the desktop window with the simulation results (Table 4).

The comparison of both t and t_{cr} (according to Student's table – 1.65) and the estimations of p-level allows to conclude that significance of predictors x_4 and x_5 is the highest, so, the rest could be excluded from the forecasting. However, considering the fact that the multivariate linear regression equation forecasts PWP in general adequately, the efficiency of the predictors' joined action in various combinations in other models was verified. For example, only three last fractions of particle size distribution were left in the model, and after that the significance of separate predictors was estimated since Equation 2 has been constructed.

Equation 2:

$y = 2.21+0.08 \cdot x_1+0.21 \cdot x_2+0.21 \cdot x_3$

$R = 0.83$; $R^2 = 0.69$; SEE = 1.70;

$F(3, 235) = 176.4$ ($F_{cr} = 8.54$); $p < 0.0000$; $N = 239$.

Predictant: y – permanent wilting point (PWP) of plants;

Predictors: x_1–x_3 – particle size distribution fractions' content (x_1 – 0.01–0.005; x_2 – 0.005–0.001; x_3 – < 0.001 mm, %)

The statistical characteristics of this equation are almost the same as in Equation 1, except for the results of each separate predictor's assessment (Table 5). The analysis of the second model not only confirmed the high significance of 0.005−0.001 and < 0.001 mm fractions in the PWP forecasting, but also proved the expediency of the involvement of 0.01−0.005 mm fraction in the multitude of predictors.

The considerable growth of *t*-criterion's parameters for all predictors together with decrease of p-level for 0.01-0.005 fraction were established. It means, the certain "combinatory" group of the predictors appeared. This phenomenon should obviously be explained by some other fields of science, but not the statistics.

Thus, the particle size distribution fractions best suitable for PWP forecasting were selected, though other important properties, such as the content of humus and exchangeable calcium, have still remained. The following equation is built with the addition to the composition of the predictors of these indices. But, despite the

Table 4. Significance Assessment of the Predictors in Equation 1

Predictor	t (t_{cr} = 1.65)	p-level
x_1(0.25–0.05)	–0.85	0.40
x_2(0.05–0.01)	–0.72	0.47
x_3(0.01–0.005)	0.60	0.55
x_4 (0.005–0.001)	**2.84**	**0.005**
x_5 (< 0.001)	**3.33**	**0.001**

Table 5. Significance Assessment of the Predictors in Equation 2

Predictor	t (t_{cr} = 1.65)	p-level
x_1(0.01-0.005)	2.22	0.03
x_2(0.005-0.001)	5.68	0.00
x_3(< 0.001)	12.79	0.00

large number of data on the content of calcium (N = = 130) and humus (N = 305), PWP parameters are not available for all profiles. So, as a result, too little samples providing all these data were included into the data set.

Equation 3:

$y = 24.55–0.55 \cdot x_1–0,27 \cdot x_2–0.06 \cdot x_3+0.16 \cdot x_4–0.34 \cdot x_5$

R = 0.83; R^2 = 0.70; SEE = 1.03.

$F(5, 5) = 2.30$ ($F_{cr} = 4.71$); p < 0.19055; N = 11.

Predictant: y – permanent wilting point (PWP) of plants;

Predictors: x_1 – x_3 – particle size distribution fractions' content (x_1 – 0.01–0.005; x_2 – 0.005–0.001; x_3 – < 0.001 mm, %);

x_4 – content of exchangeable Ca^{+2}, meq/100 g of soil;

x_5 – total humus, %.

Unfortunately, the characteristics of Equation 3, could not be considered as statistically significant because of too small available data capacity (N = 11), what is reflected to F-criterion. Therefore, PTF with this set of predictors will be obviously calibrated only after the considerable expansion of the database and accumulation of larger amount of information. But now it should be exclude from further research.

Stage Four – PWP Optimal Model's Verification and Optimal Choice. The comparison of two data sequences calculated with the aid of the equation and measured experimentally is considered as the most substantiated PTF quality control [1−3]. For this purpose, the entire data set was initially divided into two parts: 80 per cent – for the calibration and 20 per cent – for the verification of models, just in the ratio recommended by other researchers [7, 12]. The smaller set (59 models) was used for the verification of models 1 and 2.

The results of the comparison (verification) of the measured PWP parameters with those calculated using Equat. 1 and 2 are represented in Table 6.

In accordance with statistical arguments both models are equally reasonable to be used in course of the permanent wilting point forecasting for the chernozems. However, in view of the fact that model 2 includes a smaller quantity of components (predictors), its accomplishment will require less amount of initial data, i.e. the search for available data will be substantially reduced. Under certain circumstances the latter model will be more economically reasonable. It should be noted that the application of a model is expedient only for the typical and ordinary chernozems concerning the provinces of wooded-steppe, steppe and arid steppe in Ukraine. The ranges of the predictors limiting the adequacy of the model should be also considered: the content of 0.01−0.005 mm fraction – 1.7−23.4 %; 0.005−0.001 – 1.4−31.0 %; x_3 < 0.001 – 15.3−60.5 %.

Table 6. Pedotransfer Functions Characteristic

Equation	R	R^2	RMSE	L	Amount of Predictors
1	0.80	0.64	2.97	2.03	5
2	0.80	0.64	2.91	2.02	3

RMSE – root-mean square error, it designated the forecast accuracy, i.e. the approximation accuracy of the sequence's actual deviation of the equation's trend line; L – mean deviation (arithmetical average of real values' absolute deviations of the mean value).

CONCLUSIONS

The permanent wilting point of plants can be calculated by means of the pedotransfer function (multivariate linear regression equation) using the available data on the medium- and small-size silt and clay fractions rate in accordance with N. A. Kachinskyi's classification. The adequacy of forecasting calculations is confirmed with the high correlation coefficients and determination during the comparison with the measured data.

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Гранулометричний склад як базова грунтова характеристика для педотрансферного прогнозування вологості в'янення

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Вологість стійкого в'янення рослин належить до основних грунтових гідрологічних констант і є важливою характеристикою в оцінці доступності сільськогосподарським рослинам природної або зрошувальної вологи. Пряме вимірювання гідрологічних параметрів потребує тривалого часу, значних зусиль і коштів. Педотрансферні функції (ПТФ) можуть забезпечити альтернативний шлях оцінювання цих показників, шляхом розрахунку із доступних у грунтових базах даних параметрів основних властивостей грунту. **Мета.** Створення нових ПТФ для оцінювання вологості в'янення рослин у чорноземних грунтах України. **Методи**. Для створення ПТФ застосували рівняння множинної лінійної регресії. Використали дані з бази даних «Властивості грунтів України»: для калібрування моделей вибірка включала 239 наборів даних (результат прямого вимірювання) вологості в'янення і гранулометричного складу у верхньому генетичному горизонті чорноземів типового та звичайного. Окремо 59 наборів даних використано для верифікації моделей. **Результати.** Із декількох моделей найприйнятнішою визнано таку, де як суттєві незалежні змінні ідентифіковано параметри вмісту трьох гранулометричних фракцій (за класифікацією Н. А. Качинського) – 0,01–0,005, 0,005–0,001 та < 0,001 мм (%). При цьому точність прогнозу (R^2 = 0,64) є цілком допустимою. **Висновки.** Прогнозування вологості в'янення за допомогою моделі, що включає три фракції, є реально можливим, зважаючи на доступність великої кількості даних гранулометричного складу у грунтовій базі даних.

Ключові слова: гранулометричний склад, педотрансферна функція, вологість в'янення рослин, чорнозем.

Гранулометрический состав как базовая почвенная характеристика для педотрансферного прогнозирования влажности завядания

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Влажность устойчивого завядания растений относится к основным почвенным гидрологическим константам и играет важную роль в оценке доступности сельскохозяйственным растениям естественной или оросительной влаги. Прямое измерение гидрологических параметров требует значительного времени, усилий и средств. Педотрансферные функции (ПТФ) могут обеспечить альтернативный путь оценивания этих показателей косвенным (расчетным) путем из доступных в почвенных базах данных параметров основных почвенных свойств. **Цель**. Создание новых ПТФ для оценки влажности завядания растений в черноземных почвах Украины. **Методы**. Для создания ПТФ применили уравнения множественной линейной регрессии. Использовали данные из почвенной базы данных «Свойства почв Украины»: для калибровки моделей выборка включала 239 наборов измеренных данных влажности завядания и гранулометрического состава в верхнем генетическом горизонте черноземов типичного и обыкновенного. Отдельно 59 наборов данных использованы для верификации моделей. **Результаты**. Из нескольких моделей лучшей признана модель, где в качестве существенных независимых переменных идентифицированы параметры содержания трех гранулометрических фракций (по классификации Н. А. Качинского) – 0,01–0,005; 0,005–0,001 и < 0,001 мм (%). При этом точность прогноза (R^2 = 0,64) является вполне допустимой. **Выводы**. Прогнозирование влажности завядания с помощью модели, включающей три фракции, является реально возможным, учитывая наличие большого количества данных гранулометрического состава в почвенной базе данных.

Ключевые слова: гранулометрический состав, педотрансферная функция, влажность завядания растений, чернозем.

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