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SOIL MOISTURE TENSION AND SOIL SPECTRAL REFLECTANCE ON THE EXAMPLE OF THE KOSCIAN PLAIN SOILS

POTENCJAŁ WODY GLEBOWEJ A ODBICIE SPEKTRALNE GLEB NA PRZYKŁADZIE GLEB RÓWNINY KOŚCIAŃSKIEJ

INTRODUCTION

Soil surface moisture is the most dynamically changing element of bare soil in field conditions influencing the soil spectral level in the visible and near-infrared range (Milfred and Kiefer 1984; Crist and Cicone 1984). Generally, an increase in soil moisture causes a decrease in soil spectral reflectance across the visible and near-infrared spectrum. This decrease is clearer for light color soils, with a low content of organic matter, than for dark ones (Mikhaylova and Orlov 1986). Białousz and Girard (1978), collecting soil spectral data in field conditions with an Exotech radiometer, have found that soil moisture is particulary difficult to detect for dark soils of very high roughness. Epiphanio and Vitorello (1984) conclude that separating wet and dry soils by remote sensing methods heavily depends on the degree of soil surface roughness, the solar elevation

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and the angles of observation by a sensor. The influence of the illumination angle on measuring moisture content by a multiband radiometer for rough soil surfaces was then confirmed in Music and Pelletier's experiments (1986, 1988). With the increase in soil moisture from oven-dry soil to the hygroscopic capacity, changes in soil reflectance are not observed (Tolchelnikov 1974, Cierniewski 1985) or the reflectance level drops a little (Vinogradov 1976, 1983). With a further increase in water content to the field capacity, the raflectance decreases sharply, in proportion to the increase in the water content in the soil (Bowers and Smith 1972, Tolchelnikov 1974, Vinogradov 1976, 1983). A stil further increase in the soil water content to the full saturation level does not bring about any change in the reflectance (Tolchelnikov 1974, Vinogradov 1983) or causes a slight increase (Minnus (1967) in Białousz 1978, Biłousz et al. 1978, Vinogradov 1983, Cierniewski 1985, Music and Pelletier 1986). The changes in the soil reflectance over this three moisture ranges are explained by the dissimilarity of the forms of water. In the first range, from zero moisture to the hygroscopic capacity, there is only chemically bound water, water vapor and hygroscopic water. In the second one, to the field capacity, water surrounds soil particles in the form of a film or it fills capillaries and small pores. In the third moisture range it has the form of gravimetric water. The drop in soil reflectance with the increase in soil moisture is caused by the increasing proportion of liquid water to air, which is different under refraction and light conductivity (Vinogradov 1976, Reginato et al. 1977).

This paper reanalyzes soil spectral data discussed in earlier studies (Cierniewski 1985, 1988). It shows how equations describing the relationship between soil moisture tension and the spectral reflectance coefficient, calculated for different-textured soils, vary. This tension is expressed by pF, i.e., a negative common logarithm of pressure in cm of water column. The analysis was conducted on soil surface horizon samples of typical soil of the Kościan Plain in the Wielkopolska Lowland.

METHODS

The quantitative relationship between soil moisture tension and soil spectral reflectance was analyzed on the basis of laboratory spectrophotometrical measurements. They were determined on 88 soil samples put through a 1 mm sieve and placed in rings of 2.4 diameter and 1 cm height. Their top surfaces were smoothed to maximally reduce the influence of soil surface roughness. The samples were brought successively to the following twelve moisture potential values: 0, 1, 1.5, 2, 2.5, 3, 4, 4.5, 5, 5.5, 6 and 7 pF. Moisture states from 1 to 3 pF were obtained in Richard's apparatus (Drzymała et al.,1980). The states of 4, 5, 5.5 and 6 pF were determined in a chamber filled with a saturated vapor of sulphuric acid solution of concentrations at 20°C, of: 3.3%, 7%, 14%, 27% and 44%, respectively. The soil samples, brought to a given moisture potential value, were then analyzed by the SPECOL reflectometer R 45/O of Zeiss Jena, illuminating them at the angle of 45 degree and looking at them along the normal to the soil surface. The reflectance coefficient, defined as a percentage of soil spectral reflectance in comparison with the barium sulphate standard reflectance was determined for five wavelenghts: 440, 540, 640, 740 and 860 nm.

The texture of studied soils was determined by the areometric method, while organic matter content by loss-on-ignition when burned at 460°C (Lityński et al., 1972). Their color in air-dry and water saturation conditions was described using Munsell Color Charts.

RESULTS

The studied soils are situated in the Kościan Plain, one of the subregions of the Leszno Upland (Kondracki 1976). These soils lie on a flat morainic plateau, stretching along the left bank of the Warta river to the north-west of Śrem. The plateau rises about 10-20 m above the level of the Warta flood plain. It was formed during the Leszno Phase of the Baltic glaciation. Typical soils of the morainic plateau, i.e. typic brown podsolic soils, degraded black earths and typic black earths were selected for these studies. Additionally, to increase the differences in the spectral reflectance and roughness of the studied soils, initial loose denudative soils and eroded brown podsolic soils were included in the analysis. These soils are described in Table 1 and Figures 1 and 2.

Table 1
Tabela 1

Characteristics of the studied soil samples
Charakterystyka badanych prób glebowych

Ss	Soil Gleba	Texture Uziar- nienie	Content [%] of Zawartość [%]		Munsell color value Jasność barwy wg Munsella		
			C	OM	D	W	N
Id	Initial loose denudative soil gleby deluwialne właściwe	s-sl	9.7	0.88	6.7	3.6	6
Bt	Typic brown podsolic soil gleby płowe właściwe	ls-sl	2.1	1.44	6.2	3.2	30
Be	Eroded brown podsolic soil gleby płowe zerodowane	sl	11.7	1.93	5.7	4.0	6
Dd	Degraded black earth czarne ziemie zdegradowane	ls-sl	4.1	2.54	4.9	2.6	32
Dt	Typic black earth czarne ziemie właściwe	sl	9.6	4.11	4.0	2.1	14

Ss — symbol soil; C — clay; OM — organic matter; D — air-dty and W — water saturated soil; N — number of samples; s — sand; ls — loamy sand; sl — sandy loam
Ss — symbol gleby; C — ił; OM — materia organiczna; D — gleba powietrznie such i W — wysycona wodą; N — liczba prób; s — piasek; ls — piasek gliniasty; sl — glina piaszczysta

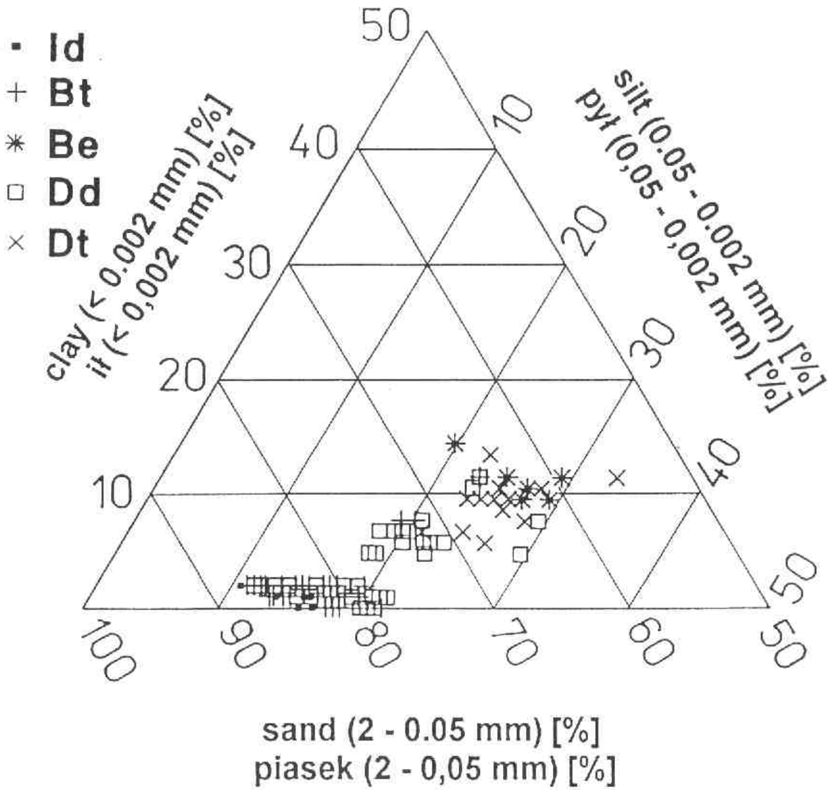


Fig. 1. Textural graph of studied soil samples
Ryc. 1. Wykres uziarnienia badanych prób glebowych

Each of the investigated samples was characterized by a constant reflectance level of above 5-5.5 pF and each wet sample showed the shine effect at the five wavelenghts measured (Fig. 3). This effect appears with an increase in the reflectance coefficient and a decrease in soil moisture tension from 1.5 to 0 pF. As a result, the lowest soil reflectance is observed at a soil-water potential of 1.5-2 pF.

In the relation described by the spectral reflectance coefficient (R), great differences in the reflectance level among the analyzed soil units are observed. For example, initial loose denudative soils (Id) demonstrate about twice as high reflectance as degraded (Dd) and typic (Dt) black earths in the whole range of the soil-water potential (P). These differences between the soil units in the R vs. P relation were reduced considerably if soil reflectance was described by a relative reflectance coefficient (βp). This coefficient,

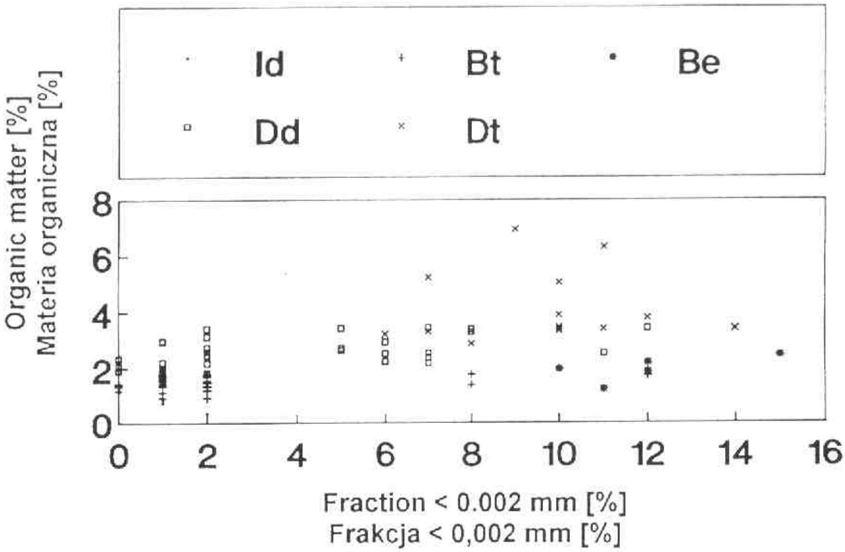


Fig. 2. Content of organic matter and clay fraction in the studied soil samples
Ryc. 2. Zawartość materii organicznej i frakcji ilastej w badanych próbach glebowych

referring to defined wave-lenghts, expresses the ratio of the soil reflectance coefficient at a given moisture tension to the reflectance coefficient of the same soil, but dried, i.e. at a moisture tension higher than 5.5 pF.

It has been found that the type βp vs. P relation is described precisely enough by a square curve equation:

$$\beta p = a + bP + cP^2 ; \tag{1}$$

supplemented above 5-5.5 pF by a linear equation:

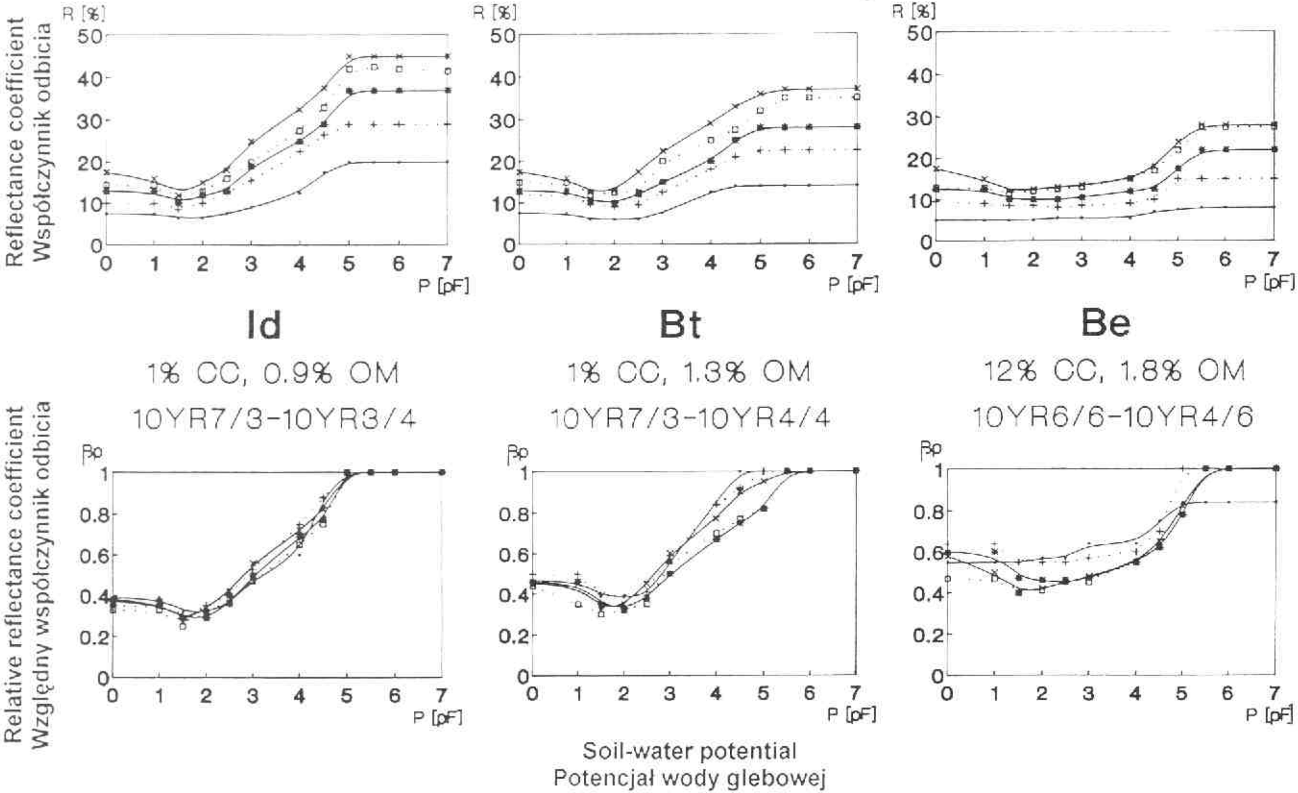
$$\beta p = 1; \tag{2}$$

where P — soil-water potential in pF and a, b, c — parameters of this equation (Fig. 4).

The significance of the curvilinear correlation coefficient (r) for each of the five soils at the five wavelenghts was determined by the F-distribution test, as:

$$F_c = \frac{r^2}{1 - r^2} \cdot \frac{n - 3}{2} ; \tag{3}$$

where n — the number of pairs of data (Pielat and Viscardi 1988). All of the computed values of F_c are greater than the tabular critical values of Snedecor's F distribution at the 0.05 significance level with 2 and n — 3 degrees of freedom (Tab. 2). So we may conclude that at the significance level each of the calculated curves reached a significant correlation for the analyzed relation.


Reflectance coefficient
Współczynnik odbicia
R [%]
P [pF]
Id
1% CC, 0.9% OM
10YR7/3-10YR3/4
Bt
1% CC, 1.3% OM
10YR7/3-10YR4/4
Be
12% CC, 1.8% OM
10YR6/6-10YR4/6
Relative reflectance coefficient
Względny współczynnik odbicia
βρ
Soil-water potential
Potencjał wody glebowej

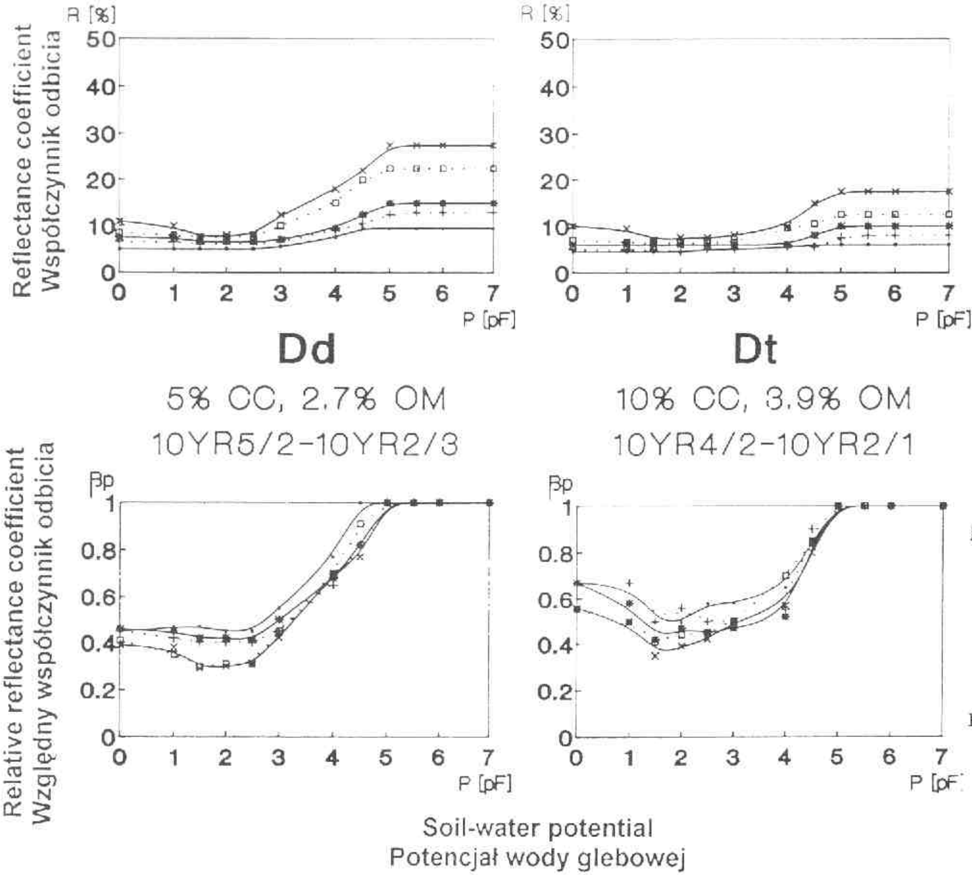


Fig. 3. Typical relation between soil-water potential and reflectance coefficient as well as the relative reflectance coefficient of the ana- lyzed soils; OM — organic matter content; CC — clay fraction content; 10YR4/2- -10YR2/1 — air-dry and water saturated soil color. Soil symbols as in Table 1

Ryc. 3. Typowe zależności pomiędzy potencjałem wody glebowej a współczynnikiem odbicia analizowanych gleb i ich względnym współczynnikiem odbicia; OM — zawartość materii organicznej; CC — zawartość frakcji ilastej; 10YR4/2-10YR2/1 — barwa gleby powietrznie suchej i wysyconej wodą. Symbole gleb — jak w tabeli 1

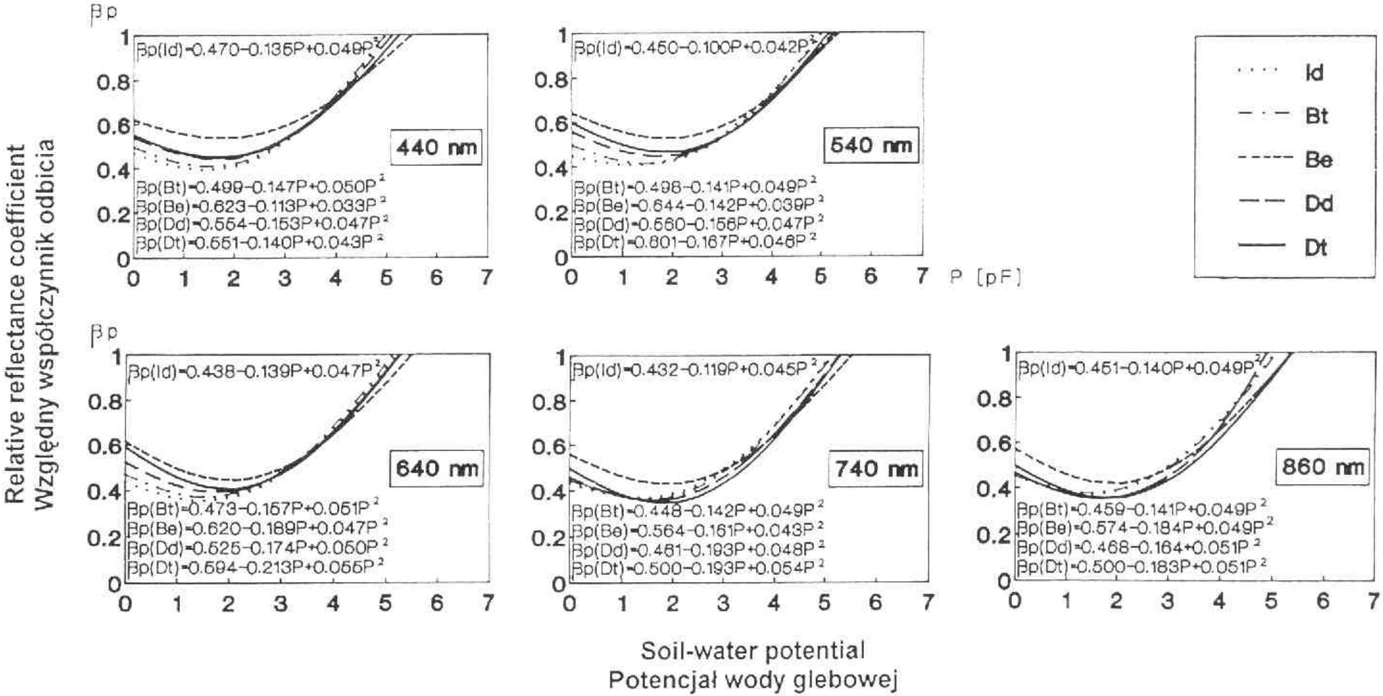


Fig. 4. Second order polynominal equations describing the relation between the relative reflectance coefficient of individual soils and their moisture potential. Soil symbols as in Table 1

Ryc. 4. Równania wielomianu drugiego stopnia opisujące zależności pomiędzy współczynnikiem odbicia poszczególnych gleb i ich potencjałem wilgotnościowym. Symbole gleb - jak w tabeli 1

Table 2
Tabela 2

Significane test of the analyzed quadratic equations
Test istotności analizowanych rownań kwadratowych

Ss	n	λ	r	F_c	F
Id	54	440	0.966	356.23	3.17
		540	0.960	302.97	
		640	0.963	324.97	
		740	0.965	346.87	
		860	0.965	343.92	
Bt	270	440	0.937	959.71	3.03
		540	0.953	1307.42	
		640	0.946	1132.16	
		740	0.954	1346.54	
		860	0.948	1173.21	
Be	54	440	0.894	101.02	3.17
		540	0.914	129.42	
		640	0.887	88.19	
		740	0.887	89.50	
		860	0.941	196.45	
Dd	288	440	0.911	697.35	3.03
		540	0.926	852.73	
		640	0.918	765.12	
		740	0.941	1103.81	
		860	0.938	1049.10	
Dt	126	440	0.883	216.84	3.07
		540	0.885	222.83	
		640	0.898	254.94	
		740	0.916	322.38	
		860	0.890	235.07	

Ss — symbol of soils; n — number of pairs of data; λ — wavelenghts; r — correlation coefficient of curvilinear regression; F_c — computed value of F-distribution calculated according to Eq. 3; F — tabular critical value of Snedecor's F-distribution at 0.05 significance level with 2 and n-3 degrees of freedom
Ss — symbole gleb; n — liczba par danych; λ — długoć fali; r — współczynnik korelacji regresji krzywoliniowej; F_c — wartość rozkładu F obliczona wg równania 3; F — krytyczna wartość rozkładu F Snedecora odnosząca się do 0,05 poziomu istotności przy 2 i n-3 stopniach swobody

A special statistical procedure (Pielat and Viscardi 1988) was used to answer the question of which of the curves tested above are similar at the same significance level as in the previous test (0.05). In the first step, parameters of a common parabolic regression, i.e. determined on the assumption that parameters b and c in Eq. 1 are the same for each of the compared parabols, were calculated. The equation of the common parabolic regression is given as:

$$\beta p = a^{(j)} + b_c P + c_c P^2; \tag{4}$$

where $a^{(j)}$ — the estimator of parameter a concerning the individual para- bola, b_c and c_c — estimators of a common regression coefficients. The b_c and c_c values were calculated by solving the system of equations:

$$b_c \sum_{j=1}^{g} \sum_{i=1}^{nj} z_{ij}^2 + c_c \sum_{j=1}^{g} \sum_{i=1}^{nj} z_{ij} c_{ij} = \sum_{j=1}^{g} \sum_{i=1}^{nj} z_{ij} d_{ij},$$

$$b_c \sum_{j=1}^{g} \sum_{i=1}^{nj} z_{ij} c_{ij} + c_c \sum_{j=1}^{g} \sum_{i=1}^{nj} c_{ij}^2 = \sum_{j=1}^{g} \sum_{i=1}^{nj} c_{ij} d_{ij};$$

$$z_{ij} = P_i^{(j)} - \overline{P}^{(j)};\ c_{ij} = P_i^{2(j)} - \overline{P}^{2(j)} \text{ and } d_{ij} = \beta p_i^{(j)} = \overline{\beta} p_{(j)};$$

where $P_i^{(j)}$, $\beta p_i^{(j)}$ the i^{th} values of P and βp in the j^{th} group of data, $\overline{P}^{(j)}$), $\overline{P}^{2(j)}$), $\overline{P}^{(j)}$ — adequate means of the j^{th} group of data, nj — the number of data in the j^{th} group, g — the number of compared groups. The $a^{(j)}$ coefficients are individually calculated for each of the group from the formula:

$$a^{(j)} = \overline{\beta} p^{(j)} - b_c \overline{P}^{(j)} - c_c \overline{P}^{2(j)} \tag{5}$$

The curvilinear correlation coefficient (r) of the common parabolic regression is defined as:

$$r = \sqrt{1 - E / \left(\sum_{j=1}^{g} \sum_{i=1}^{nj} d_{ij}^2 \right)} . \tag{6}$$

In the second step, the similarity of the regression was determined by the F-distribution test as:

$$F_s = \frac{(E - E')/2(g-1)}{E/(N-3g)};\ E = \sum_{j=1}^{g} \sum_{i=1}^{nj} \left(\beta p_i^{(j)} - a^{(j)} - b P_i^{(j)} - c P_i^{2(j)} \right)^2; \tag{7}$$

where $n = \sum_{j=1}^{g} nj$. The hypothesis is that $b^{(j)} = b_c$ and $c^{(j)} = c_c$, for $j = 1,2,...g$. An alternative hypothesis is that at least one of the identities is not true. If computed values of F_s are lower than the tabular values of Snedecor's F-distribution with $2(g-1)$ and N-$3g$ degrees of freedom at the given significance level, the hypothesis of the similarity of the parabolas is accapted.

The results of the test and parameters concerning the common parabolic regression are presented in the Table 3. They prove that only two groups of the studied soils show the similarity at the 5 per cent significance level for each of the analyzed wavelenghts. The similarity was found between initial loose denudative soils (Id) and typic brown podsolic soils (Bt) and also between degraded black earths (Dd) and typic black earths (Dt), but not for 640 nm.

Table 3
Tabela 3

Parametres of the similarity test
Parametry testu podobieństwa

Soil symbols / Symbole gleb	n	λ	Parameters of common parabolic regression / Parametry wspólnej regresji parabolicznej				r	F_s	F
			b_c	c_c	$a_{(1)}$	$a_{(2)}$			
Id + Bt	324	440	-0.1451	0.0500	0.4836	0.4958	0.9417	0.1860	3.03
		540	-0.1343	0.0475	0.4889	0.4901	0.9533	1.8063	
		640	-0.1537	0.0501	0.4528	0.4699	0.9484	0.2698	
		740	-0.1381	0.4830	0.4481	0.4447	0.9555	0.5077	
		860	-0.1406	0.4903	0.4567	0.4581	0.9504	0.1553	
Dd + Dt	414	440	-0.1489	0.0458	0.5559	0.5478	0.9025	1.5796	3.02
		540	-0.1593	0.0466	0.5699	0.5771	0.9129	2.6677	
		640	-0.1859	0.0518	0.5431	0.5536	0.9102	3.2638	
		740	-0.1647	0.0501	0.4766	0.4651	0.9324	2.3331	
		860	-0.1697	0.0508	0.4813	0.4705	0.9232	2.9694	
Bt + Dd	324	440	-0.1499	0.0486	0.5215	0.5329	0.9217	13.5633	3.01
		540	-0.1487	0.0477	0.5262	0.5330	0.9361	20.6230	
		640	-0.1656	0.0505	0.4976	0.5022	0.9302	10.9615	
		740	-0.1473	0.0486	0.4656	0.4448	0.9463	7.6824	
		860	-0.1527	0.0498	0.4827	0.4464	0.9415	7.4339	
Be + Dt	180	440	-0.1321	0.0401	0.6080	0.5574	0.8767	5.6114	3.05
		540	-0.1593	0.0440	0.6420	0.6017	0.8885	2.3245	
		640	-0.2058	0.0527	0.5973	0.6115	0.8913	3.1800	
		740	-0.1831	0.0510	0.5528	0.5048	0.9042	5.6551	
		860	-0.1829	0.0506	0.5590	0.5064	0.9014	1.0034	

n — number of pairs of data; λ — wavelenghts; b_c , c_c, $a_{(1)}$, and $a_{(2)}$ — parameters of Eq. 4.; r — correlation coefficient of curvilinear regression; F_s — computed value of F-distribution calculated according to Eq. 7; F — tabular critical value of Snedecor's F-distribution at 0.05 significance level with $2(g\text{-}1)$ and $N\text{-}3g$ degrees of freedom
n — liczba par danych; λ — długoć fali; b_c, c_c, $a_{(1)}$ i $a_{(2)}$ — parametry równania 4; r — współczynnik korelacji regresji krzywoliniowej; F_s — wartość rozkładu F obliczona wg równania 7; F — krytyczna wartość rozkładu F Snedecora odnosząca się do 0,05 poziomu istotności przy $2(g\text{-}1)$ i $N\text{-}3g$ stopniach swobody

Eroded brown podsolic soils, of much higher clay content (Tab. 1), are dissimilar to the remaining soils at the 5 per cent significance level.

The parabolas of these similar soils were also tested to answer the next question whether they are identical at the 0.05 significance level, which implies the possibility that one general equation may replace the individual equations in the groups of similar soils. It required the examination of the hypothesis that coefficients a, compound for each of the individual regression, also are the same. The hypothesis was tested by the F-distribution function:

$$F_1 = \frac{(G-E)/(g-1)}{E/(N-g-2)}; \; G = \sum_{j=1}^{g} \sum_{i=1}^{nj} \left(\beta p_i^{(j)} - a_g - b_g P_i^{(j)} - c_g P_i^{2(j)}\right)^2. \tag{8}$$

Refering the computed value of F to table of critical values of Snedecor's Fi-distribution at a significance level with g-1 and N-g-1 degrees of freedom, we may accept the mentioned hyppthesis if the computed value is equal to or less than the tabular value.

The results of the test confirm the possibility of using general equation for the same two groups of soils which were determined as similar, i.e. initial soils and typic brown podsolic soils (Id + Bt), and also degraded black earths and typic black earths (Dd + Dt) (Fig. 5, Tab. 4).

Table 4
Tabela 4

Parametres of the identity test
Parametry testu identyczności

Soil symbols Symbole gleb	n	λ	Parameters of generl parabolic regression Parametry ogólnej regresji parabolicznej a	b	c	r	F_i	F
Id + Bt	324	440	0.4938	-0.1451	0.0500	0.9415	1.1223	3.87
		540	0.4899	-0.1343	0.0475	0.9533	1.5641	
		640	0.4671	-0.1537	0.0501	0.9480	2.7645	
		740	0.4453	-0.1381	0.0483	0.9555	0.1256	
		860	0.4579	-0.1406	0.0490	0.9504	0.1685	
Dd + Dt	414	440	0.5534	-0.1489	0.0458	0.9024	0.7961	3.86
		540	0.5721	-0.1592	0.0466	0.9128	0.7795	
		640	0.5463	-0.1859	0.0518	0.9100	1.4636	
		740	0.4731	-0.1647	0.0501	0.9321	2.1090	
		860	0.4780	-0.1697	0.0508	0.9230	1.6369	

n — number of pairs of data; λ — wavelenghts; a,b,c — parametres of Eq. 1; r — correlation coefficient of curvilinear regression; F_i — computed value of F-distribution calculated according to Eq. 8; F — tabular critical value of Snedecor's F-distribution at 0.05 significance level with g-1 and N-g-2 degrees of freedom

n — liczba par danych; λ - długoć fali; a,b,c — parametry równania (1); r — współczynnik korelacji regresji krzywoliniowej; F_i — wartość rozkładu F obliczona wg równania 8; F — krytyczna wartość rozkładu F Snedecora odnosząca się do poziomu istotnoci 0,05 przy g-1 i N-g-2 stopniach swobody

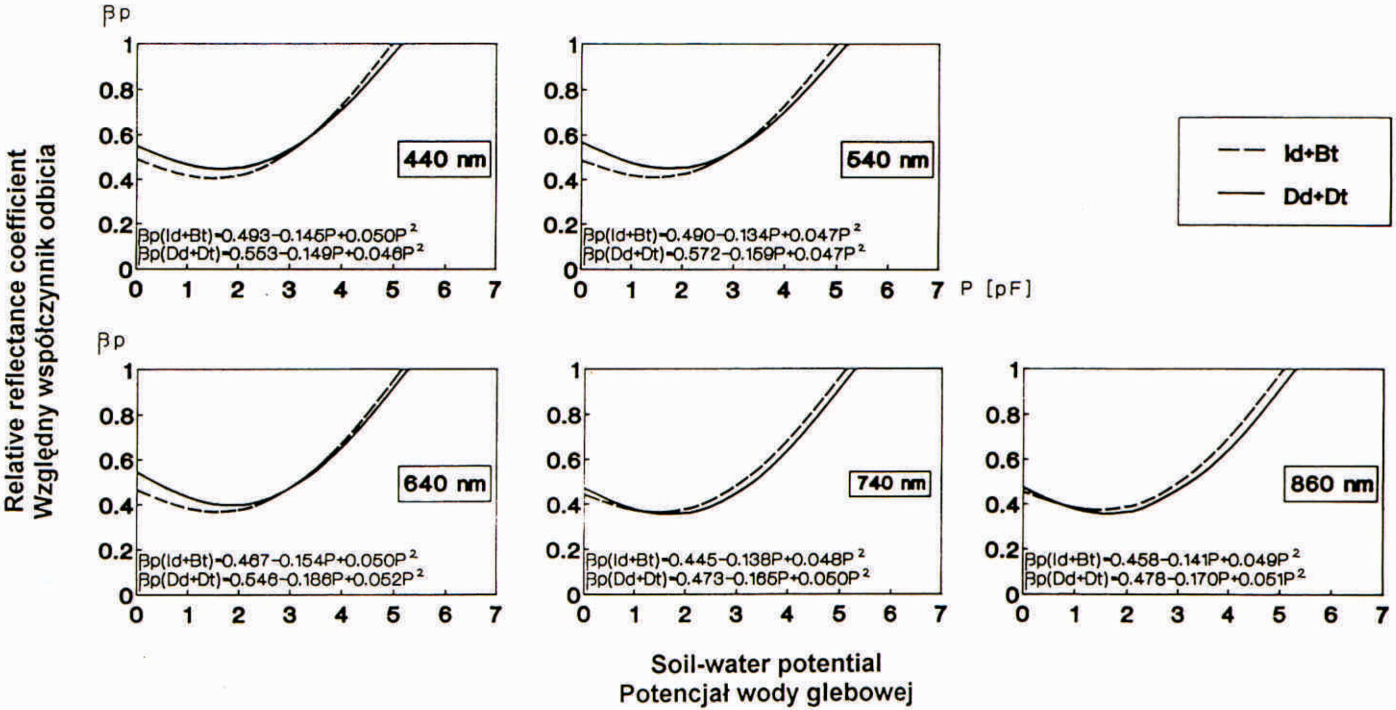


Fig. 5. Second order polynominal equations describing the relation between the relative reflectance coefficient of the distinguished soil groups and their moisture potential. Soil symbols as in Table 1

Ryc. 5. Równania wielomianu drugiego stopnia opisujące zależności pomiędzy współczynnikiem odbicia wybranych grup glebowych i ich potencjałem wilgotnościowym. Symbole gleb - jak w tabeli 1

DISCUSSION

In the light of Tolchelnikov (1974) and Vinogradov's (1976) explanation that the form of water contained in the soil surface between two water retention states, i.e. the hygroscopic capacity and the field capacity, decides about soil reflectance differentiation under the influence of moisture, a soil parameter was sought which would be closely related to these retention states. Thus, the moisture potential, describing the force required to pull water from the soil, was choosen for this study.

The results of many previous experiments have proved that the relationship between the soil reflectance level and soil moisture, expressed as a proportion of a mass of water to a mass of dry soil, heavily depends on soil texture (Bowers and Smith 1972, Tolchelnikov 1974, Vinogradov 1976, Białousz 1978, Białousz and Girard 1978, Vinogradov 1983, Musick and Pelletier 1986). When analyzing the relationship between the content of gravimetric water in soil samples of texture from sand to silty clay and they spectral reflectance in the range from 0.3 to 0.82 μm, Mac Dowall et al. 1972 (in Myers 1975), found that this relationship was different even among soils belonging to the same texture class. To reduce those differences, Music and Pelletier (1988) proposed expressing water content as the percentage of water retained at 0.1 bar tension, and earlier by Cierniewski (1985) and Crist et al. (1986) as soil moisture tension.

The influence of soil texture on soil reflectance is clearly demonstrated in Vinogradov's work (1983), describing this influence mathematically by three separate functions: 1) a power function — from absolutely dried soil to the maximum hygroscopic capacity (H), 2) an expotential function — from H to the field capacity (F), and 3) a linear function — from F to full water saturation.

The upper inflection point of these functions, indicating the hygroscopic capacity, for sands, loamy sands, sandy loams and loams, corresponds to the water content of 1%, 2%, 4% and 6% respectively, while the lower point, describing the field capacity to a water content of 5%, 8%, 14% and 22% respectively.

The hygroscopic state corresponds to a soil-water potential between 4.5 and 4.7 pF, whereas the field capacity state to 2 pF (Hanks and Ashcroft 1980). The inflection points obtained in this work are at 5-5.5 pF and 1.5 - 2 pF, respectively (Fig. 5). They show that sharp changes in soil reflectance appear in a wider water retention range than has been supposed thus far.

An increase in soil reflectance near absolute saturation of soil with water was also noted by Minus (1967) (in Białousz 1978), Janza (1975), Cierniewski (1985), Musick and Pelletier (1986). Vinogradov (1983) explains this effect by a decrease in soil surface microroughness as a result of the saturation of soil pores with gravimetric water. The compared curves show almost the same amplitude of the spectral reflectance of dry and wet soils.

Wet soils, with moisture near the field capacity have about 2.5 times lower reflectance than dry soils with soil-water potential higher than the hygroscopic capacity. It confirms Obukhov and Orlov's opinion (1964) that soil under absolute water capillary saturation demonstrates about 2-3 times lower reflectance in the visible range than in the dry state. Idso et al. (1975), studying different soils, estimated this value at 2. The results of the present author's own studies, supported by the results of the discussed works of Vinogradov (1983) and Idso et al. (1975), prove that the relative reflectance of wet soil (with almost absolute water saturation) does not depend on soil texture. This statement is incompatible with Tolchelnikov's (1974), who records a ratio of reflectance coefficient of dry to water saturated soil of sands, loams and clay loams of 1.6, 2 and 2.3, respectively.

CONCLUSIONS

The results of this work demonstrate that the use of pF as a measure of soil moisture tension to describe soil reflectance vs. soil moisture, reduces differences in this relation among the five analyzed soils: loose denudative soils (Id), typic brown podsolic soils (Bt), eroded brown podsolic soils (Be), degraded black earths (Dd) and typic black earths (Dt). The relation concerning four of the soils may be expressed as for two soil units, joining together initial soils with typic brown podsolic soils (Id + Bt) and degraded black earths with typic black earths (Dd + Dt).

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Streszczenie

Do określenia ilościowej relacji pomiędzy potencjałem wody glebowej a odbiciem spektralnym gleb w zakresie od 440 do 860 nm wykorzystano glebowe dane spektrofotometryczne uzyskane w warunkach laboratoryjnych. Każdą z 88 badanych prób glebowych, o uziarnieniu od piasku do gliny piaszczystej i o zawartości materii organicznej od 0.3% do 5.2%, doprowadzono do 12 stanów wilgotności (odpowiadających określonym wartościom potencjału wody glebowej), a następnie mierzono ich współczynniki odbicia. Wyniki badań wskazują, że posłużenie się potencjałem wody glebowej w opisie matematycznym relacji: odbicie spektralne gleby — jej wilgotność, stwarza możliwość sformułowania jednego równania dla kilku gleb jednocześnie. Zamiast czterema oddzielnymi równaniami dotyczącymi: gleb deluwialnych właściwych (Id), gleb płowych właściwych (Bt), czarnych ziem zdegradowanych (Dd) i czarnych ziem właściwych (Dt) można posłużyć się dwoma, wykorzystując wspólne równania dla Id i Bt oraz Dd i Dt.

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