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EFFICACY OF SOME EXTRACT SOLUTIONS IN DETERMINING SOIL CONTENT OF MANGANESE READILY AVAILABLE FOR PLANTS

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Soil content of manganese readily available for plants is being determined by several chemical methods but their efficacy for this purpose is not always adequately proved. It is shown by different terminal values for the individual methods, leading often to controversial results [2]. Thus there is a necessity of choosing the most proper method the results of which would be the best correlated with the results of vegetative experiments.

This paper presents the results of investigations on dependences between the soil content of some manganese forms and the concentration of this trace element in total dry matter of the above-ground parts of summer rape and field bean, when their vegetation was over. This correlation was taken as a criterion for estimating the efficacy of the method applied for determining manganese available for plants.

METHODS

Field and pot experiments with summer rape (Bronowski IHAR variety) and field bean (Fioletowy Czyżowskich, Major THZ variety) were carried out, for 4 years, on 8 soils. The soils used for these experiments contained different quantities of total manganese and of its forms considered as available for plants.

Before sowing plants, the following forms of manganese were determined in soils:

— total manganese according to Rinkis method [8],
— soluble in 20% HCl [5],
— easily reducible according to Jones-Leeper [9],
— active according to Schachtschabel [10],
— soluble in acetate solution according to Baron [1], and
— soluble in water boiling for 5 minutes [4].

Manganese in soil extracts and in plant substance was determined using colorimetric persulphate method.

RESULTS AND DISCUSSION

In Table 1 the soils are ranged successively according to increasing content of manganese soluble in water, in order to stress that the remaining forms of manganese do not form a similar row. This is proof

Table 1

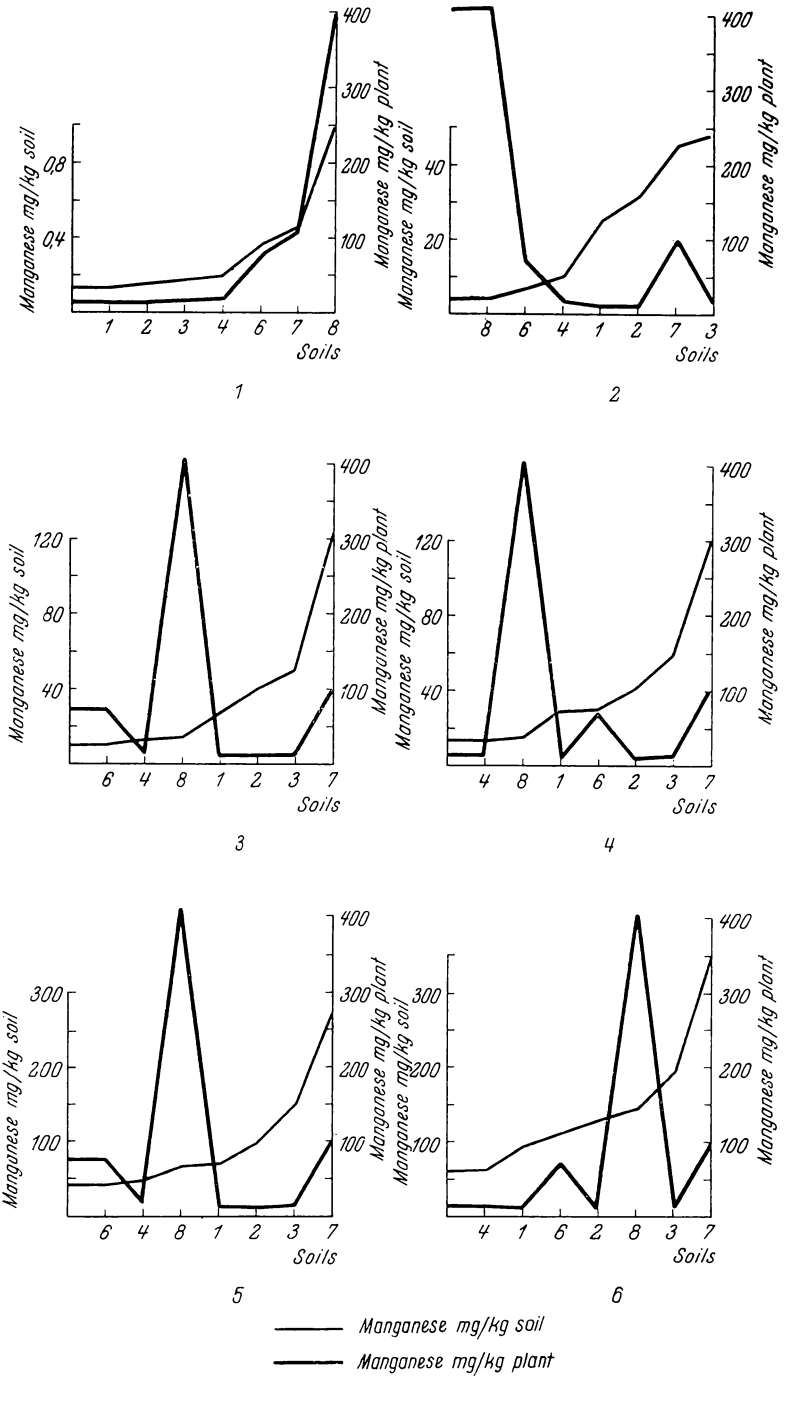
Soil content of different forms of manganese and its total quanity in summer rape and field bean grown on these soils

No. soil	Mechanic fraction <0.02 mm in % of soil	pH		Manganese in mg/kg soil dry matter						Manganese in mg/kg dry matter	
		H_2O	KCl	1	2	3	4	5	6	summer rape	field bean
1	10.3	6.77	6.36	0.13	25.6	27.3	29.0	70	93	11.9	30.6
2	15.5	6.93	6.43	0.15	32.1	39.5	41.6	100	128	11.0	26.9
3	20.7	7.10	6.50	0.17	48.1	50.0	58.5	150	195	13.7	37.9
4	5.1	6.61	6.29	0.19	10.2	13.0	13.5	48	60	14.3	38.7
5	8.8	6.75	5.82	0.25	6.6	62.5	75.5	275	275	-	66.0
6	4.5	5.75	4.69	0.35	6.9	10.3	30.2	40	112	72.3	187.3
7	15.5	7.30	6.80	0.45	44.7	117.5	122.5	275	350	102.7	-
8	5.0	5.65	4.60	1.00	4.0	15.5	14.5	65	145	405.6	-
Sum		summer rape		2.44	171.6	271.1	309.8	748	1083	631.5	387.4
		field bean		1.24	129.5	202.6	248.3	685	863		
Correlation coefficient		summer rape		+0.990*	-0.469	-0.139	-0.169	-0.074	+0.135		
		field bean		+0.947*	-0.557	-0.427	-0.093	-0.225	-0.025		

Comment: 1 - manganese soluble in water at 5 minutes boiling,
2 - manganese soluble in acetate extract according Baron's method,
3 - active manganese, according to Schachtschabel,
4 - ready reducible, according to Jones-Leeper,
5 - manganese soluble in 20% HCl,
6 - manganese soluble in concentrated H_2SO_4, according to Rynkis,
* - significant at the 1% level of probability.

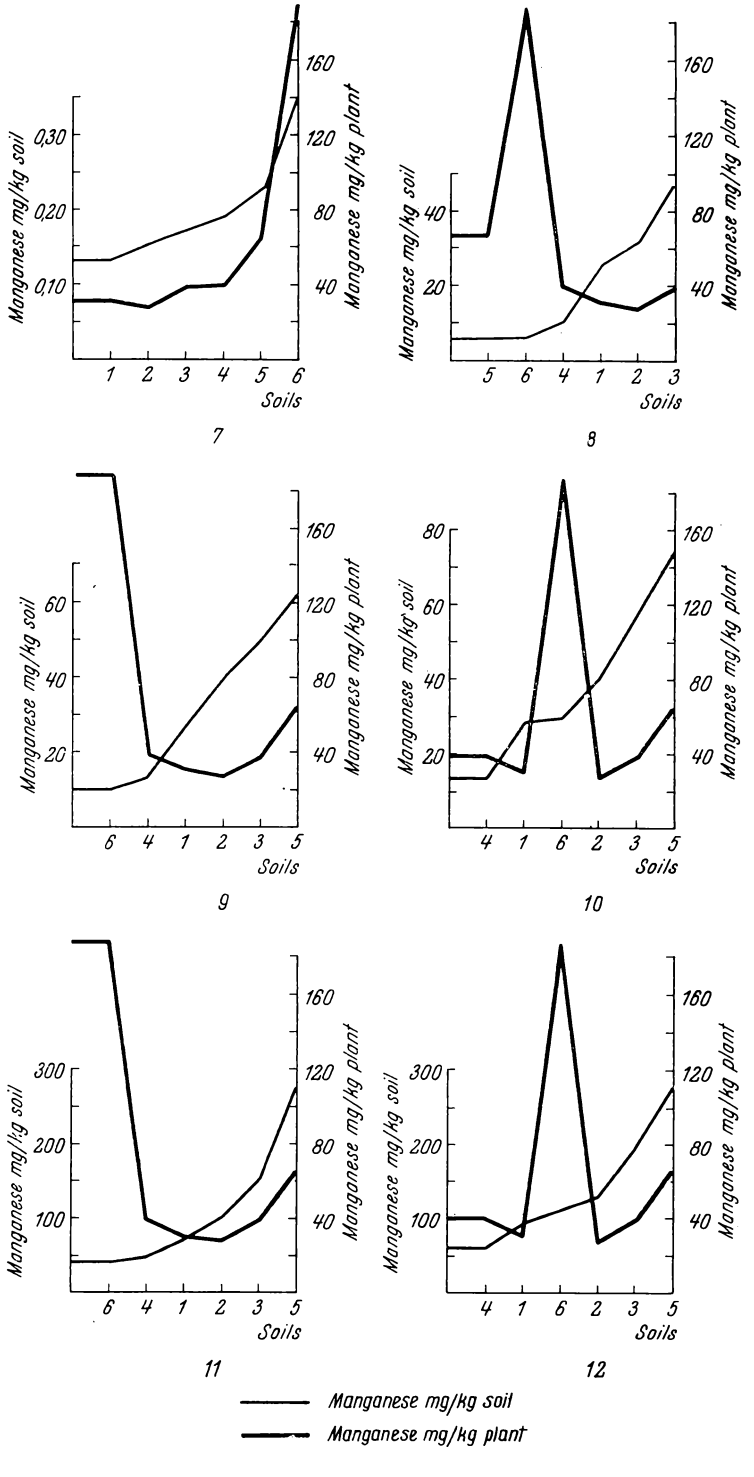
of lack of quantitative dependence between the soil contents of water soluble manganese and of other investigated forms of this trace element. No dependence was also found between soil content of manganese determined by Baron's method, and active, and easily reducible manganese and the total manganese content in above-ground mass of summer rape and field bean. In the soils No. 1, 2, 3, 4 and 5, much richer in the manganese forms mentioned above, the concentration of this element in the tested plants is much lower than in the plants grown on the soils No. 6 and 8 which are much poorer in these forms of manganese. The highest maganese content in above-ground parts of summer rape was found on soil No. 8 which was the poorest in manganese determined by Baron's method. Correlation coefficients "*r*" calculated for dependence between the soil content of manganese determined by Baron's method and the concentration of this trace element in summer rape (Tab. 1 and Fig. 2) and in field bean (Tab. 1 and Fig. 8) have negative values. Probably the soil content of manganese determied by this method does not reflect the quantity of manganese really available for plants. In literature, however, we find data which ascribe to the Baron's extract solutio an activity similar to Egner's buffer [3]. Our results do not support these data as regards manganese assimilable by summer rape and field bean. Results concerning manganese active and easily reducible give rise to similar reservations. Correlation coefficients calculated for active manganese are negative for summer rape (Tab. 1 and Fig. 3) as well as for field bean (Tab. 1 and Fig. 9). Negative are also values of correlation coefficients for manganese easily reducible: for summer rape $r = -0.169$ (Fig. 4) and for field bean $r = -0.093$ (Fig. 10). The discussed three forms of manganese did not show closer dependence betwen their content in soil and total manganese concentration in the tested plants than manganese soluble in 20% HCl (Fig. 5, 11) and in concentrated H_2SO_4 (Fig. 6, 12). Ruszkowska [7] also indicated the lack of correlation between soil content of easily reducible and total manganese and the concentration of this trace element in lettuce leaves. The above mentioned forms of manganese should not be taken as a basis in determining the need of fertilizing soil with this element. However, the quantity of active manganese is taken as a basis for such prediction.

The obtained differences between the content of manganese in the mentioned plants indicate a distinct and recurring correlation between soil content of manganese soluble in water and the concentration of manganese in summer rape (Tab. 1 and Fig. 1) and in field bean (Tab. 1 and Fig. 7). It is confirmed by the correlation coefficients close to one.



Correlation between soil content of different forms of manganese and its concentration in summer rape

Fig. 1. Manganese soluble in water boiling for 5 minutes, Fig. 2. Manganese soluble in acetate solution according to Baron, Fig. 3. Manganese active according to Schachtschabel, Fig. 4. Manganese easily reducible according to Jones-Leeper, Fig. 5. Manganese soluble in 20% HCl, Fig. 6. Manganese soluble in concentrated H_2SO_4



Correlation between soil content of different forms of manganese and its concentration in field bean

Fig. 7. Manganese soluble in water boiling for 5 minutes, Fig. 8. Manganese soluble in acetate solution according to Baron, Fig. 9. Manganese active according to Schatschabel, Fig. 10. Manganese easily reducible according to Jones-Leeper, Fig. 11. Manganese soluble in 20% HCl, Fig. 12. Manganese soluble in concentrated H_2SO_4

Wetter [11], Mc Hargue, Hiltner and Rademacher (cit. after Roth and Pfaff, [6]) reported similar dependences in oat used as an index plant.

CONCLUSIONS

Basing on the results of investigations we can draw the following conclusions:

1. The forms of soil manganese, thought to be available for plants, are not assimilated in equal degree by summer rape (Bronowski IHAR variety) and field bean (Fioletowy Czyżowskich, Major THZ variety).

2. The soil content of manganese soluble in acetate solution according to Baron, active according to Schachtschabel and easily reducible according to Jones-Leeper did not show correlation with the content of this trace element in dry matter of above-ground mass of summer rape and field bean.

3. A highly significant correlation was found between soil content of manganese soluble in water and the concentration of this element in total dry matter of summer rape and field bean after their vegetation was over. Presumably soil content of manganese soluble in water may be used as a basis for dividing soils into those which require and do not require fertilization with this trace element, and for evaluating their need of fertilizing.

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H. KUKURENDA

UTILITÉ DE CERTAINES SOLUTIONS D'EXTRACTION POUR DÉTÉRMINER DANS LE SOL LE MANGANÈSE FACILEMENT ASSIMILABLE PAR LES PLANTES

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Résumé

Les observations avaient pour but de définir l'utilité de certaines solutions d'extractions pour détérminer dans le sol le manganèse accessible aux plantes. On détérmina le manganèse dans le sol avant les semailles dans les extractions du sol suivantes:

1) aqueuse avec ébullition de cinq minutes [4],
2) d'acétate selon Baron [1],
3) à 20% HCl [5],
4) concentrée de H_2SO_4 selon Rinkis [8]. On détérmina aussi le manganèse actif selon Schachtschabel [10] et pouvant étre facilement réduit selon Jones-Leeper [9].

On effectua l'appréciation des méthodes sus-mentionnées en comparant leurs résultats avec la concentration du manganèse dans la masse au-dessus de la terre du colza d'été (Bronowski IHAR) et des févorole (Violette de Czyżowskich, Major THZ) après que leurs végétation fut terminée. Les plantes furent cultivées dans huit sols différents en expériences aux champs et en pots pendant quatre ans.

On effectua le choix des sols pour les observations en prenant en considération la plus grande différenciation de leur teneur en formes de manganèse sus-mentionnées.

En résultat des observations de quatre années on constata seulement une réelle corrélation entre la teneur du sol le manganése aqueuse avec ébullition de cinq minutes, et la concentration du manganèse dans la masseau dessus du plante cultive, apres achévement du vegetation (table 1 et dess. 1, 7). La contenu en sol des restes formes le manganése ne demontra pas réel du correlation (dess 2, 3, 4, 5, 6, 8, 9, 10, 11, 12). La correlation pour eitees formes du manganèse est negative (table 1).

H. KUKURENDA

EIGNUNG EINIGER EKSTRAKTIONSLÖSUNGEN ZUR BESTIMMUNG DES FÜR DIE PFLANZEN LEICHT AUFNEHMBAREN MANGANS IM BODEN

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Zusammenfassung

Zweck der Untersuchungen war, die Eignung einiger Ekstraktionslösungen zur Bestimmung des für die Pflanzen leicht aufnehmbaren Mangan im Boden abzuschätzen. Das Mangan wurde in den Böden vor der Pflanzensaat in folgenden Bodenauszügen bestimmt:

1) Wasserauszug nach 5 min. Kochdauer [4],
2) Azetatauszug nach Baron [1],
3) Auszug in 20% HCl [5],
4) Auszug in konzentrierter H_2SO_4 nach Rinkis [8].

Es wurde auch aktives Mangan nach Schachtschabel [10] sowie leicht reduzierbares Mangan nach Jones-Leeper [9] bestimmt.

Die Bewertung der obengenannten Methoden wurde auf Grund eines Vergleiches deren Ergebnisse mit der Mangankonzentration in ganzer oberirdischen Masse des Sommerrapses (Bronowski IHAR) und der Pferdebohne (Fioletowy Czyżowskich), nach Beendingung der Vegetation derselben, durchgeführt. Die Pflanzen wurden auf acht verschiedenen Bodentypen in Gefäss- und Feldversuchen 4 Jahre hindurch angebaut. Die Wahl der Böden für die Untersuchungen wurde unter Berücksichtigung der höchsten Differenzierung der obengennannten Manganformen in denselben durchgeführt (Tab. 1).

Auf Grund der vierjährigen Untersuchungen wurde eine signifikante Korrelation nur zwischen dem Gehalt des im Wasser nach dem 5 min. Kochen auflösbaren Mangans und der Mangankonzentration in ganzer oberirdischen Masse der untersuchten Pflanzen nach Beendigung der Vegetation derselben (Tab. 1 und Abb. 1, 7) festgestellt. Der Gehalt der sonstigen untersuchten Manganformen in den Böden wies keine signifikante Korrelation auf (Abb. 2, 3, 4, 5, 6, 8, 9, 10, 11, 12). Die Korrelationskoeffiziente zeigten für diese Manganformen negative Werte (Tab. 1).

H. KUKURENDA

PRZYDATNOŚĆ NIEKTÓRYCH ROZTWORÓW EKSTRAKCYJNYCH DO OZNACZANIA W GLEBIE MANGANU ŁATWO DOSTĘPNEGO DLA ROŚLIN

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Streszczenie

Badania miały na celu określenie przydatności niektórych roztworów ekstrakcyjnych do oznaczania w glebie manganu dostępnego dla roślin. Mangan oznaczano w glebach przed siewem roślin w następujących wyciągach glebowych:

1) wodnym przy 5-minutowym gotowaniu [4],
2) octanowym wg Barona [1],
3) 20-procentowym HCl [5],
4) stężonym H_2SO_4 wg Rinkisa [8].

Oznaczono również mangan aktywny wg Schachtschabela [10] oraz łatwo ulegający redukcji wg Jones-Leepera [9].

Oceny wymienionych metod dokonano porównując ich wyniki z koncentracją manganu w całej masie nadziemnej rzepaku jarego (Bronowski IHAR) i bobiku (Fioletowy Czyżowskich, Major THZ) po zakończeniu ich wegetacji. Rośliny uprawiano na ośmiu różnych glebach w doświadczeniach wazonowych i polowych w okresie 4 lat. Doboru gleb do badań dokonano uwzględniając jak największe zróżnicowanie w nich zawartości wymienionych form manganu (tab. 1).

W wyniku czteroletnich badań stwierdzono jedynie korelację istotną między zawartością w glebie manganu rozpuszczalnego w wodzie przy pięciominutowym gotowaniu a koncentracją manganu w całej masie nadziemnej badanych roślin po zakończeniu wegetacji (tab. 1 oraz rys. 1 i 7). Zawartość w glebach pozostałych badanych form manganu nie wykazała istotnej korelacji (rys. 2, 3, 4, 5, 6, 8, 9, 10, 11, 12). Współczynniki korelacji dla tych form manganu posiadają wartości ujemne (tab. 1).

Х. КУКУРЕНДА

ПРИГОДНОСТЬ НЕКОТОРЫХ ЭКСТРАКТОРОВ ДЛЯ ОПРЕДЕЛЕНИЯ В ПОЧВЕ МАРГАНЦА ЛЕГКО ДОСТУПНОГО ДЛЯ РАСТЕНИЙ

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Резюме

Целью исследований была оценка пригодности некоторых экстрагирующих растворов для определения почвенного марганца доступного для растений. Перед посевом растений определяли марганец в следующих почвенных вытяжках:

1) водной при 5-минутном кипячении [4],
2) ацетатной по Барону [1],
3) 20% HCl [5] и
4) концентрированной H_2SO_4 по Ринкису [10].

Определяли также активный марганец по Шахтшабелю [10] и легко поддающийся восстановлению марганец по Джонес-Леперу [9].

Оценку вышеназванных методов проводили сравнивая их результаты с концентрацией марганца в надземной массе ярового рапса (Броновски ИХАР) и кормовых бобов (Гйолетовы Чыжовских, Майор ТХЗ) после окончания их вегетации. Растения выращивали на восьми различных почвах в вегетационных и полевых опытах в течение четырех лет. Почвы для исследований выбирали с учетом наибольшей дифференциации содержания названных форм марганца (таб. 1).

В результате 4-летних исследований установлена существенная корреляция только между содержанием в почве марганца растворимого в воде при пятиминутном кипячении и концентрацией марганца в надземной массе исследованных растений после окончания вегетации (таб. 1 и рис. 1 и 7). Содержание в почве остальных форм марганца не выявило существенной корреляции (рис. 2, 3, 4, 5, 6, 8, 9, 10, 11 и 12). Коэффициенты корреляции для этих форм марганца дают отрицательные величины (таб. 1).