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Application of saponite-containing basaltic tuffs to improve the cultivation of vegetable crops

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Introduction

Saponite, $(Ca_{0.5},Na)_{0.3}[(Mg,Fe)_3(Si,Al)_4O_{10}](OH)_2 \times 4H_2O$, is a clay mineral of the montmorillonite/smectite group.

It is present in basaltic tuffites and tuffs of Vendian (Neoproterozoic) age (Volyn series, Rataychitsa stage) in the south-west of the Republic of Belarus. Depending on their localization, the depth of stratified tuffs ranges from 40 to 1500 m. The saponite-containing tuffs (SCT) are a by-product of basalt exploration. Along with saponite, the basaltic tuffs are composed of analcime, hematite, hydromica, kaolinite, feldspars and quartz.

Apart from industrial applications (e.g., for Portland cement, ceramic products, glass) and for the removal of toxic metals and radionuclides, saponite-containing tuffs are used in agriculture as an Mg source to improve the nutrition of agricultural crops.

The aim of the study was to test the agronomic effectiveness of SCT in the cultivation of selected vegetable crops. We hypothesize that the byproduct SCT has the potential of an effective and low-cost Mg source in plant production.

Material and methods

We carried out a field experiment on a Eutric Retisol (arenic) in the Republic of Belarus from 2014 to 2019.

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We used a composite sample of SCTs from three locations (from the Pinsk, Ivanava and Malaryta district of the Brest region of the Republic of Belarus).

The composite sample contained 8.2% MgO, 2.1% K_2O, 0.16% N, 0.23% P_2O_5, 2.8% Na_2O, 1.0% CaO, 20.6% FeO, 13.0% Al_2O_3, 49.5% SiO_2, 162.4 mg kg^{-1} von Mn, 4.5 mg kg^{-1} von Co, 35.4 mg kg^{-1} von Zn, 51.7 mg kg^{-1} von Cu and had a pH (KCl) of 8,2.

The field experiment included: 1) a control variant without fertilization, 2) a variant with NPK fertilization (carbamide, ammoniated superphosphate, KCl) during the pre-sowing cultivation, 3) various doses of SCT (20, 40, 60 or 80 kg MgO ha^{-1}; Mg_{20}, Mg_{40}, Mg_{60}, Mg_{80}), 4) a variant with magnesium sulfate (Mg_8).

The cultures under investigation were green beans (*Phaseolus vulgaris* L.), basil (*Ocimum basilicum* L.), blue fenugreek (*Trigonella caerulea* (L.) Ser.) and dill (*Anethum graveolens* L.).

Results and discussion

Preplant application of saponite-containing basaltic tuffs in Mg doses of $Mg_{20–80}$ increased yield of green beans by 14,2–16,2 $dtha^{-1}$, green mass of basil – by 0,16–0,22 kg/m^2, green mass of blue fenugreek – by 0,12–0,26 kg/m^2, green mass of dill – by 0,14–0,18 kg/m^2, with better agronomic efficiency in case of application of Mg_{40} (*Phaseolus vulgaris* L. and *Trigonella caerulea* (L.) Ser.) and Mg_{20} (*Ocimum basilicum* L. and *Anethum graveolens* L.) against the background of complete mineral fertilizing (table 1–2).

Foliar treatment of the crops using magnesium sulfate (Mg_8) increased the yield of green beans – by 14.1 $dtha^{-1}$, green mass of basil, blue fenugreek and dill – by 0.08–0.13 kg/m^2.

Conclusions

The experiments on the sod-podzolic loamy soil showed that the best indicators of agronomic efficiency in the cultivation of blue fenugreek, dill, green beans and basil were achieved in case of preplans application of saponite-containing basaltic tuffs in Mg doses of Mg_{40} (leguminous crops) and

Mg_{20} (green crops) against the background of complete mineral fertilizing.

Key words: saponite-containing basaltic tuffs, magnesium, blue fenugreek, dill, green beans, basil.

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Table 1. Influence of fertilizers on productivity of green beans and blue fenugreek

Green beans, $dtha^{-1}$			Green mass of blue fenugreek, kg/m^2		
variants	total yield	increased yield	variants	total yield	increased yield
Control	158.1	–	Control	1.18	–
$N_{50}P_{60}K_{120}$	251.7	–	$N_{40}P_{40}K_{70}$	1.52	–
NPK + Mg_8	265.8	14.1	NPK + Mg_8	1.60	0.08
NPK + Mg_{40}	265.9	14.2	NPK + Mg_{20}	1.64	0.12
NPK + Mg_{60}	267.9	16.2	NPK + Mg_{40}	1.73	0.21
NPK + Mg_{80}	267.1	15.4	NPK + Mg_{60}	1.78	0.26
CD_{05}	12.2		CD_{05}	0.07	

Table 2. Influence of fertilizers on productivity of dill and basil

Green mass of basil, kg/m^2			Green mass of dill, kg/m^2		
variants	total yield	increased yield	variants	total yield	increased yield
Control	2.06	–	Control	0.83	–
$N_{45}P_{60}K_{90}$	2.29	–	$N_{60}P_{50}K_{80}$	1.07	–
NPK + Mg_8	2.42	0.13	NPK + Mg_8	1.19	0.12
NPK + Mg_{20}	2.45	0.16	NPK + Mg_{20}	1.21	0.14
NPK + Mg_{40}	2.51	0.22	NPK + Mg_{40}	1.24	0.17
NPK + Mg_{60}	2.46	0.17	NPK + Mg_{60}	1.25	0.18
CD_{05}	0.12		CD_{05}	0.05	