АГРОЭКОЛОГИЯ

PLANT EFFECT ON NUTRITIVE CONTENTS IN BROWN SOILS OF UKRAINE

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In mountain typical brown and black-brown soils have optimum conditions for agricultural development. Even in conditions of hard crossed relief of mountains, they are located in small masses. Brown soils are formed in mountain conditions with a subtropical climate and insufficient humidity when the soil structure has enough cations Ca^{2+} and Mg^{2+}, and reaction of the soil environment makes pH 7.5 – 9.0 in the surface layer of carbonates (1 – 5 %). Alkaline pH, presence of carbonates, and also insufficiency of humidity make dominants in formation of brown soils. The transition line passes from gray soils to gray-brown, then to black-brown and at last to mountain forest black – brown soils. The humus content differs from 3 – 6 % in gray brown soils, 4.5- 6 % in mountain brown typical soils and up to 10 – 15 % in black-brown soils. The soil formation process occurs in mountain conditions at height 1000 – 3000 m above sea level. In the soil maps, they appear in desert Cuba to the south-central Asia, and occupy the most part of Pakistan and Iran, some to Azerbaijan and Iraq, and pass across Turkey. Its geographic name is termed as subtropical arid (semi-desert) and high arid (deserted) region. Such soils are also in the north and the south of Africa, in the south USA (Texas, Colorado), in the south of South America and in the southwest of Australia. The small part of brown soils (about 6 - 7 *%)* is in Asia. These soils are rich in humus. Humus promotes the alkalinity and presence of carbonates in the top genetic horizon and form organic colloids which will be easily accumulated and kept in the future. Preservation of these soils is not caused by leaching. Organic content accumulation (humification) is caused by the favorable solar irradiation. Brown soils were formed in high-mountainous conditions, where the south has cold winter and promotes preservation of humins and fulvates. Therefore they have significant stability in time if the human actions will not disturb their balance and not cause rural development and the erosive phenomena. Microelements are termed as the chemical elements, which are found in soil and biological organisms. They are related to such elements: boron (B), manganese (Mn), molybdenum (Mo), copper (Cu), zinc (Zn), cobalt (Co), iodine (I), fluorine (F), etc. In this research our purposes were: a) determination of the nutritive element contents: N, P, K; b) determination of microelement contents: Pb, Cu, Zn, Cd, Mn, and Co.

Materials and Methods:

Our research objects were brown soils of south mountain coast of Crimea in Ukraine. Soil samples were taken in the Nikitsky botanical garden as depths: 0 – 10 cm, 10 – 20 cm, 20 – 30 cm, 30 - 40 cm, and 40 - 50 cm. We sowed the soil samples by sieve No.7 and No,5 mm and weighed them defining percentage of sand in the soil, throwing away sand, grinded soil by a pestle in the mortar, sowed them through a sieve No. 1 mm, and weighed again the soils determining the percentage of sand in soil. The soil sample variants were: a) the natural soils: No.l: Red-brown soil on deluvial limestone (south exposition 15 - 18°); No.2: Brown soil on clay slates (north-eastern exposition 15 - 20°); No.3: Red – brown soil on deluvial limestone (east exposition 3 – 5°); b) the park soils: No.4: Brown soil on deluvial limestone under oak; No.5: Brown soil on deluvial limestone under cedar; No.6: Brown soil under bamboo.

Results & Discussions

Nitrogen is the exceptionally important biogenic element; it enters to all proteins, chlorophyll, nucleic acids, phosphatides and many other organic matters of a living cell. The basic mass of soil nitrogen is concentrated in organic matter. The nitrogen rate directly depends on the

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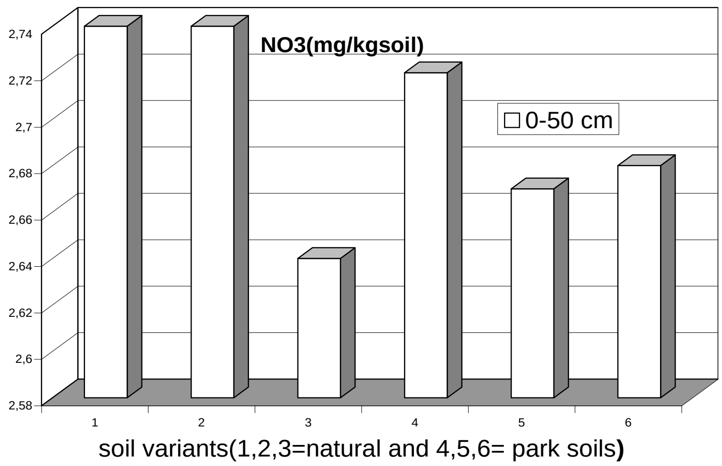
soil organic matter content and first of all on humus. For the majority of soils, nitrogen forms 1/20 - 1/12 of humus. Accumulation of nitrogen in soil is caused by its biological accumulation from free atmospheric nitrogen. Parent rocks contain low nitrogen. Nitrogen is accessible to plants mainly in the form of mineral compounds like as: ammonium, nitrates, nitrites which are released under decomposition of the nitrous organic matter as following: organic matter$\rightarrow$ ammo acids$\rightarrow$ amides$\rightarrow$ ammonium$\rightarrow$ nitrites$\rightarrow$ nitrates. Nitrites as an intermediate product practically are not in the soil. Ammonium and nitrate nitrogen are the basic forms of nitrous compounds which plants take up. Ammonium nitrogen is less accessible to plants, than nitrate but NH_4 ion is easily adsorbed by soil in fixed condition. NO_3 ion which is not adsorbed by soil neither chemically, nor physical-chemically, is mainly in the soil solution and easily used by plants. In damp areas, nitrates are subject to leaching especially in the steam engine field. Availability of nitrogen for plants depends on speed of decomposition of mineralized organic matters. However, it is impossible to provide obtaining high yields only by mobilization of natural stores of nitrogen, even on rich humus soils. Plants need nitrogen very much. Among all nutritive elements, nitrogen is needed by plants first of all from soil. Therefore, the high requirement of plants for nitrogen demands restocking soil nitrogen [1].

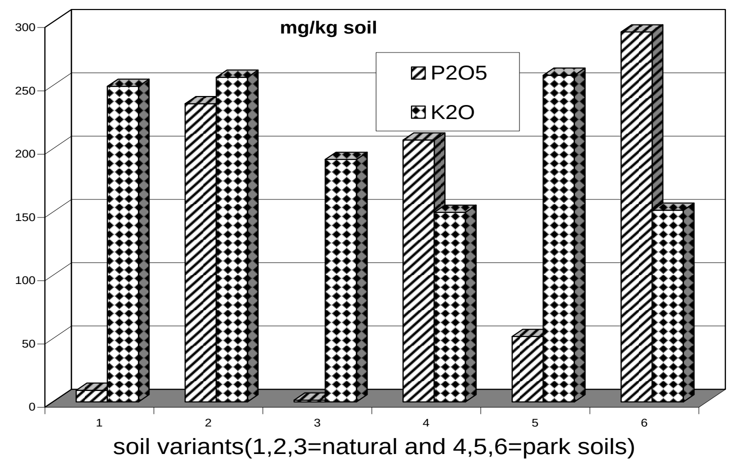
Phosphorus enters to many organic compounds that without them, vital activity of organisms is impossible. Plants contain 10% P_2O_5 on dry matter. As it is taken up much by plants, biological phosphorus is accumulated in top soil. The gross content of P_2O_5 in chernozem soil is about 0.35 % and more. In soils, phosphorus is in the form of organic and mineral connections. Organic compounds are as: phytines, nucleic acids, nucleoproteins, phosphatides, glycophosphates, etc. Mineral forms of phosphorus are mainly as: salts of calcium, magnesium, iron and aluminum of ortho-phosphoric acids. Phosphorus can be found in soil in mineral structure of apatite, phosphorite and vivianite, and also in absorptive condition of phosphate – anion. The apatite which is the protosource of all soil compounds of phosphorus, is in many magmatic rocks and it forms 95 % of phosphorus compounds in the earth crust. Mineral phosphorus in soils is presented as the low mobile forms. As dissolubility of phosphates of calcium, magnesium, aluminum and iron reduces, their foundation increases. Acid soils chemically contain active forms of iron and aluminum, and here phosphorus is more as iron phosphates and aluminum ($FePO_4$, $AlPO_4$, $Fe_2(OH)_3PO_4$, $A1_2(OH)_3\,PO_4$, etc.) or connected to oxides as the adsorptive connections, capable for particulate exchange of phosphate ions which are included in their structure. In neutral or weakly alkaline soils, calcium phosphates prevail. In rich calcium soils, calcium phosphates gradually transform to most stable form of apatite hydroxyl $Ca_3(PO_4)$, $Ca(OH)_2$, more than 3-calcium phosphate $Ca_3(PO_4)_2$. Mineral phosphates are the basic phosphorus source for plants. Phosphorus of organic compounds is taken up mainly after their mineralization. Optimum pH for plants is caused by phosphate ions as low acidity (pH 6 - 6.5). Phosphoric fertilizers are expediently applied almost on all soils [2].

Potassium plays an important role in physiologic functions in organisms. It is needed much many for plants, especially for potato, root crops, grasses, and tobacco. The potassium content in soils is high. On soils of heavy mechanical texture, gross content of K_2O is 2 % and more. It is much less in soils of light mechanical texture. The basic part of potassium is in soil as crystal lattice primary and secondary minerals in the low accessible form for plants. Some of these minerals, such as biotite and muscovite, release potassium easily and they can serve as the source of mobilization of accessible potassium. Potassium is in the soil as an absorptive form (exchangeable and not exchangeable) and as simple salts. Potassium of simple salts is readily available to plants, but its rate not definite. The basic source of potassium for plants is the exchangeable potassium. As accessibility is more, its saturation in soil is more. Not exchangeable or fixed potassium is hard accessible. However, there is a balance between exchangeable and not exchangeable potassium in soil. At need of exchangeable potassium, its stores are replenished by not exchangeable potassium. In conditions of low accessible potassium, plants feel its lack [3].

Our results showed that, NO_3 contents in the natural soils were stable, and in park soils had the increased trend by depth. But NO_3 contents in natural soils were more than park soils and it is established that, cultural plants acquire and absorb NO_3 more than natural plants. It is visible that, the highest P_2O_5 contents were in the park soils (under bamboo). In general, planting factor increases P_2O_5 contents in the soil. Also we found that, natural soils contain K_2O more than park soils. Thus it is concluded that, soil processing and planting factor reduce K_2O contents in the soil composition.

Microelements play the main physiological and biochemical role in life of plants, animals and human. They enter in vitamins, ferments, hormones. Abnormal (excessive or lack) content of microelements in food and products causes to disturb metabolism and develop diseases for animals and human. So, at lack of iodine is developed endemic thyroid for animals and human; at lack of fluorine: caries; at excess of fluorine: endemic flourosis; at excess of molybdenum: gout; at lack of copper in forages for lambs causes enzootic ataxia, for lambs and other animals (grazing in the pasture soils in which is much boron), causes nervous breakdowns and pneumonias.





Nutritive elements (NO_3, P_2O_5, and K_2O) in the brown soils of Crimea in Ukraine, 2004(0 — 50 cm).

Lack of microelements in soil sharply reduces crop yield and quality. For example, lack of copper in soils causes lodging in plants, no ripeness, and sharp reduction in yield. At lack of boron, there is hard emergence of stamen's filaments, failing ovary, reducing seed yield, damaging plants by diseases (rot in sugar beet, bacteriosis of flax). Lack of zinc causes resetting in deciduous trees. In many researches have found close relation between microelement contents in soil on the one hand, and plant yield animal productivity, and human health, on the other hand. So, the mountain soils represent biogeochemical provinces with an endemic thyroid; in these soils, waters and foodstuffs, there is in 2-5 times of less iodine, than in those places where there is no endemic thyroid. The soil is the main source of microelements in plants, which are used by animals and human. In this point, analysis of the microelement content in soils is interesting for resolving practical questions of plant, animal veterinary sciences and medicine. Study of distribution basics of microelements in soils presents scientific basis of microelement application as fertilizer for plants and mineral supplements for animals [4]. During weathering and soil formation, one group of microelements is collected in soils, others are leached and lost. One group of microelements in soils is more than in the lithosphere (for example, I, B). Another group is less (for example, Cu, Co). The basic sources of microelements in soils are soil formative rocks. The soils subjected to weathering of acidic rocks (granites, liparites), are poor in Ni, Co, Cu, and soils subjected to weathering of basic rocks (basalts, gabbros), are rich in those. The main soil formative rocks of taiga-forest, forest – steppe, and steppe zones (i.e. bouldered, covered, and forest – clayed) contain approximately equal quantity of Zn, Co, Cu and Mo and only fluvioglacial sands and sandy loam soils contain less than as: Mo in 2-3 times, and the others in 4-7 times. The degree of this change is defined by features of soils, soil-forming processes, and properties of microelements, There are microelements in soils: 1) in the crystal lattice primary and secondary minerals as isomorphism adulteration; 2) in the form of insoluble compounds (salts, oxides); 3) in the ionic – exchange condition; 4) in the composition of organic matter; and 5) in the soil solution. The huge role in migration of microelements and their biological accumulation is played by the highest and lowers plants [1]. Roots of plants extract microelements from the sub-soil horizons and parent rocks and translocate them to top-soil layers. In biogenic accumulation of microelements in soils, there is the special great role of the plant - concentrators extracting plenty of microelements. For example, milk vetches, sweet clover, and figwort contain Mo in ash in 100 and 1000 times more than in rocks while in ash of other plants, its content is as same as or a little more than rocks. The mobility of microelements in soils, their migratory ability, accumulation or deletion, and availability to plants are affected by pH, oxidation-reduction conditions, CO_2 concentration, and soil organic matter. At acid reaction of soils, mobility of Mo decreases, but of Cu, Zn, Mn, and Co increases. Some of microelements (B, I, F) have mobility, both in acidic and alkaline conditions. Microelements with variable valence in dependence on oxidation-reduction conditions of soil can pass from the highest valence to the lowest and vice versa, that is essentially reflected in their migratory ability. Under change of anaerobic conditions by oxidants (aerobic), some microelements transform from the lowest valence to the highest, form insoluble connections and reside as deposits: $Mn^{2+} \rightarrow \underline{Mn^{3+}}\downarrow$, others, vice versa, get mobility and easily migrate; $Cr^{3+}\downarrow \rightarrow Cr^{6+}$; $\underline{V^{3+}}\downarrow \rightarrow V^{5+}$. The big influence on mobility of microelements is done by CO_2 concentration in soil solution. Such microelements as Mn, Ni, Ba, Sr, etc., are capable to form carbonate acid salts (carbonates and bicarbonates). At increasing of CO_2 concentration in soil solution, carbonates transform to bicarbonates i.e. their dissolubility and migratory ability of microelements is increased. The mobility of microelements in soils is affected by humus and low molecular organic acids such as formic, citric, oxalic, etc. Some microelements form soluble compounds by organic matters, others (Cu, I) are fixed and become inaccessible for plants.

The microelement contents in the brown soils of Crimea in Ukraine, 2004 (0 - 50 cm)

Soil No.	Nutritive contents (mg / kg soil)					
	Pb	Cu	Zn	Cd	Mn	Co
Natural soils						
1	8.28	1.32	3.62	0.84	115.40	0.24
2	8.70	0.86	3.36	0.06	64.60	0.22
3	9.9S	0.96	3.34	0.08	98.0	0.24
Park soils						
4 (oak)	10.38	0.82	2.44	0.28	54.40	0.24
5 (cedar)	9.90	0.98	3.00	0.66	84.80	0.26
6 (bamboo)	10.38	1.22	3.36	0.70	95.40	0.36

The content of microelements and their distribution in the profile of various soil types are not equal. In sod-podzolic soil, the maximal content of microelements as Zn, Co, Mo, Cu is observed in rocks (horizon C); in podzolic horizon, there are less than 50 % in comparison with rocks, and in the humus horizon, more than podzolic horizon, but all of them less than rocks. In chernosems, microelements are more in humus horizons than in rocks. Soils are characterized very poor by mobile forms of microelements as followings: Cu<0.3, Zn<0.2, Mn<l, Co<0.2, Mo<0.05, B<0.1 mg/1 kg soil, and poor as: 1.5, 1, 10, 1, 0.15, and 0.2, respectively. It is apparent that, there is a probable effect of application of microelements as quality of fertilizers [2]. Our results showed that, at all, Pb, Cd, and Co were more and Cu, Mn, and Zn were less than natural soils.

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Abstract

To study micro- and macroelement regime affected by different plants in red-brown and brown soils, an experiment was conducted on the south mountain soils of Crimea in Ukraine in 2004. Results showed that, in the natural soils, nitrogen, potassium, copper, zinc, and manganese were more, and phosphorus, plumb, cadmium, and cobalt were less than the park soils. At all, soil solution reaction (pH) in both of them was neutral.

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