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Phosphorus content in three physical fractions of typical Chernozem

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The widespread use of fertilizers makes it necessary to study not only the content but also the forms of occurrence of nutrients in soil, as well as the phase in which nutrients are transferred. These characteristics determine the availability of chemical elements for plants, but remain insufficiently studied. In this work we attempted to gain insight into the distribution of organo-mineral fractions in agriculturally used Chernozem from Voronezh (Russia) and the distribution of phosphorus – one of the most important nutrient elements – in this type of soil.
We compared the distributions of phosphorus in physical fractions of the soil in 3 experimental groups: the control group (without fertilizers), the group fertilized with 1 dose of NPK, and the group fertilized with 2 doses of NPK. The soil was sampled during the period of treatment with fertilizers and during the period of aftereffect (4 years after the last application of fertilizers).
In order to analyze organo-mineral fractions, we used size-density fractionation to separate the soil samples into three physical fractions: clay-associated fraction with particle size < 1μm (CF), light fraction with particle density < 2.0 g cm$-$3 (LF), and residual fraction > 2.0 g cm$-$3 (RF). Total phosphorus content (TPC) in the fractions was determined with Agilent 5100 ICP-AES spectrometer.
To compare groups, simultaneous confidence intervals were computed from pooled variance estimators in ANOVA, and Fisher's LSD test was used.
We showed that during the period of treatment with fertilizers LF increased proportionally to the dose of fertilizers, and a simultaneous reduction in RF was observed. During the period of aftereffect, the content of these fractions tended to the control value. The increase of LF may indicate increasing availability of nutrients, since this fraction is likely to participate in biological cycles.
The analysis of TPC in fractions suggested that during the period of treatment with fertilizers most of phosphorus accumulates in CF. In the group with double dose of fertilizers TPC in F was more than 1.5 times higher than in the control, while for LF the increase in TPC was not significant, and RF TPC was practically the same as in the control. Association of phosphorus predominantly with CF suggests that phosphorus was mainly adsorbed to the surface of clay particles rather than to organic components. Therefore, despite the increase in CF TPC as a consequence of treatment with fertilizers, the increase in availability of phosphorus is questionable. In the aftereffect period no significant differences in TPC were found.
In conclusion, we showed that availability of fertilizers may be dependent on fractional composition of soil. Under our experimental conditions, phosphorus tended to bind predominantly to clay particles. However, in the aftereffect period, fractionation of TPC was similar to the control, indicating the need to further investigate the fate of phosphorus in soils.