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Assessing the potential of using biochar from chicken manure as a soil amendment

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Organic farming means excluding the use of synthetic fertilizers, pesticides, genetically modified organisms, plant growth regulators, hormones and antibiotics in plant growing. However, it is necessary to support soil fertility in organic farming. Chicken manure belongs to the most worldwide spread organic animal wastes. It contains a lot of nutrients necessary for plants, but it is highly toxic. After treatment (anaerobic fermentation and composting) chicken manure can be used as an organic fertilizer. Another way of chicken manure treatment, pyrolysis, helps to produce biochar, which, unlike compost and digestate, is the source of so called slowly releasing carbon. Chicken manure often contains plant substrate (straw or sawdust). Biochar procuded from plant resiudes is characterized with high porosity, which helps to successfully immobilize microorganisms on it.
The aim of this study was to assess the potential of biochar produced from chicken manure as soil fertilizer. To improve biochar fertilizing properties, it was modified by means of immobilization of microbes. As biochar is the source of carbon, free-living nitrogen fixers extracted from soddy-podzolic soil (55°34'N, 49°03'E, Tatarstan, Russia) were chosen as strains for immobilization on biochar. Before inoculating biochar it was necessary to analyze its initial characteristics. Biochar produced from chicken manure from a poultry plant (Tatarstan, Russia) was used. The temperature of pyrolysis was 500°C. The biochar received was characterized with the of 5.80±0.21, EC of 6.42±0.30mS•cm-1, moisture of 6.75±0.10%, CEC of 7.6±0.26 cmol•kg^{-1}. The content of TOC in the biochar received was 24.93±3.2%, the content of TKN was low – 0.33±0.03%. Phosphorus and sulphur content was 13±0.15 and 4.90±0.17 g•kg-1, correspondingly. Currently the Russian legislation has no regulatory structure describing the quality of biochar used as a soil improver. Therefore the obtained biochar was compared with GOSTR 53765-2009 regulating the use of poultry manure as an organic fertilizer and GN 2.1.7.2041-06 regulating soil quality. Gross sulfur content in sample of biochar exceeds the specified standard for soils (GN 2.1.7.2041-06). Compared to GOST R 53765-2009 chicken manure biochar corresponds to all the standards, except for nitrogen content. The analysis of particle size was carried out using two methods: SEM and laser particle size analyzer. The ChM sample is nonhomogeneous and its particle size varies between 2 and 2000 μm. The SEM method helped to determine the size of pores (1.26-2.15 μm) and revealed generally irregular surface of the particles, which will make it possible to immobilize Azotobacter genus bacteria. The fertilizing qualities of biochar were assessed in a contact test with barley (Hordéum vulgáre). The germination index was 78%, which shows no negative effect on the plants, but no fertilizing effect either. However, biochar is the source of slowly releasing carbon, that is why it is probable that its fertilizing properties will reveal not immediately after the application. Thus, according to the aim of the investigation chicken manure biochar was analyzed and the potentiality of immobilizing Azotobacter genus bacteria on it and the use of such biochar as a fertilizer within the framework of organic farming was determined.