The Bauxite Residue as Amendment for the Acidic Soils Rehabilitation in Romania

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Abstract

This paper is reporting the results of a multistage research program concerning the use of bauxite residue (BR) from Bayer alumina production process as alkaline amendment for rehabilitation the acidic soils from Romania. First stages cover the preliminary laboratory and glass house experiments with carefully selected soil compositions and plant species. The further experimental stages are regarding for open field experiments on maize, wheat and sunflower plants grown in acidic soils under carefully selected conditions. In all these stages, the remediation of acidic soils was assisted by some complementary adjuvant for raising the soil fertility close to a sustainable level. In all the open field experiments two property control adjuvant were used: the bauxite residue for pH control and the NPK mineral fertilizers as sources of macro and micronutrients. In both glass house and open field experiments the particular targets were: a) Set up meaningful experimental tests for demonstration of the BR efficiency as acidic soils remediation material; b) Monitoring the plants growth response to the BR; c) Monitoring the soil changes in compositions and properties before and after harvesting; d) Finding effective adjuvant formulations for the plants under experiments; e) Statistical validation of the results and comparing the original data with data in real agricultural practice; f) Better understanding of the BR rehabilitation effect on soil properties and composition after the rehabilitation program; g) Accumulating credible data about the crop outputs and the grains quality achieved in the best variants of acidic soils remediation and use them for a reasonable application at larger scale in Romania.

By amending the Albota luvosoil type acidic soils (Romania) with significant bauxite residue doses, under well managed fertilization, the surface reshaped layer of acidic soil acquired initially 1.0 - 1.3 units higher in pH. Also, the crop may rise with 30 to 60 %.

Keywords: Bauxite residue, Acidic soils, Remediation, Open field experiments, Glass house experiments.

1. Introduction

This paper concludes a cycle of investigations concerning the use of bauxite residue (BR) from the alumina and aluminum industry as an alkaline amendment for improving the quality of acidic soils. The preliminary tests were done on various plants at the laboratory scale, using various

acidic soils conditioned with BR and with common fertilizers to ensure the plants chances for adaptation to continue the vegetative cycle until fruiting [1-4]. But, the first successful experiments were made later, when both the Albota acidic soil and BR coming from Sierra Leone bauxite was fully characterized and, on the basis of previous researches, it was decided that normal fertilizers doses should be applied in order to activate the neutralization effects of BR on the Albota soil acidity. With this conclusion, the next step of researches was the experiment in glass vegetation house [5,6]. The results obtained in the vegetation house confirmed the doses of bauxite residue proposed to control the acidity of the Albota soil and showed that the fertilizers used (NPK and fermented manure) can contribute to obtaining sustainable maize harvests. Moreover, this experiment demonstrated that the BR, coming from Sierra Leone bauxite processing, has a suitable mineralogy for the intended purpose and a stable chemical composition with limited possibilities of releasing heavy metals or toxic elements in soil. Also, two reports drawn up in 2011 and in 2017 confirmed the absence of radioactive elements in both bauxite and bauxite residue. The measurements were carried out by the Horia Hulubei National Institute for Research and Development in Nuclear Physics and Engineering (IFIN-HH) Bucharest.

With the new knowledge accumulated after conducting the experiments in the greenhouse, in 2018 were started the experiments in the open field: 2018 - maize, already published [5], 2019 – wheat, partially published [7] and 2020 sunflower, unpublished.

The purpose of this work is to present a review of the entire experimental material, accumulated in the period 2018-2020, regarding the testing of bauxite residue as an alkaline amendment in rehabilitation of the acidic luvosoil of Albota (Arges) Romania. The study refers to the optimization of the doses size and the frequency of application of the amendment in the crops of maize, wheat and sunflower.

2. Experimental

Experimental plants varieties were a) Maize grown in the open field experiment, 2018: Hybride DKC 4590; b) Wheat grown in the open field experiment, 2019: Hybride PG 102; c) Sunflower grown in the open field experiment, 2020: Hybride Puntasol CL. In all experiments the soil was fertilized with NPK 20.20.20 (urea) and Bio Enne with 12 % organic nitrogen, 23 % soluble sulphuric anhydride and 35 % organic carbon.

Location for carrying out all the experiments was the Agricultural Research and Development Station of Albota - Pitesti, Arges County, Romania. The entire research program was developed and supervised by National Research and Development Institute for Soil Science, Agro-chemistry and Environment–ICPA Bucharest, Romania. Also, the entire morphometric and chemical analysis programs were carried out according the National and European standards and methodology. The open field experiments set up for all above plants were organized on 13 variants (Table 1) with 3 repetitions laid in latin square, as in previous papers [5-7]. Each of the 13 variants lays in plots of 50 sqm size (10 x 5 m), all of them being included in a 2500 sqm non-irrigated area (Figure 1). Mainly, these arrangements help to understand the effects of bauxite residue on plants growth at different dosages.

application of BR on the soil of Albota does not have the expected effect, mainly due to the reported deficiencies. As a measure to increase the fertility of the Albota soil, alkalization with BR must be accompanied by a significant intake of NPK fertilizers and organic carbon fertilizers. In the conducted studies, two NPK fertilizers were used: urea and organic Bio Enne Coactyl complex fertilizer. Under these conditions, the profile of plant productions for all 3 cultivated plants (Figure 1) carries the profile of the pH of the soil in which the plants grew (Figure 2). e) All cultivated plants recorded exceptional crop yields with the beneficial contribution of meteorological factors and due to the valuable water reserves available in the soil, all during the three-year experiments.

6. References

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