THE NEED FOR CHALKING AND CHEMICAL FERTILIZERS APPLICATION ON THE ALBOTA ALBIC LUVISOL

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Abstract
A field experiment was carried out at SCDA Pitești, on an Albic Luvisol with a 25.0-25.2% clay content, with soy crop, Raluca TD variety. Seeds were treated with Bradyrhizobium japonicum, the density was 45-50 germinable grains/m^2, and the distance between rows 50 cm. Fertilizers were applied during the vegetation cycle as follows: Dual 1 liter/ha, Décor 0,5 liters/ha, and Pulsar 1 liter/ha. The experimental design included 12 variants with the following chemical fertilizers doses: N_0P_0, $N_{40}P_{40}$, and $N_{80}P_{80}$. Agrocalcium (a product obtained by lime fine grinding, with a minimum 90% calcium carbonate content) and Doloflor (100% BIO fertilizer based on bitter spar with a minimum 50% calcium and magnesium oxide content) were used as chalking. Doloflor application as powder and granules in a 2.5 t/ha dose without N and P fertilization modified the soil reaction and pH registered values of 5.3-5.5, in the moderately acid reaction domain. Doloflor powder and granules in 2.5 t/ha dose together with $N_{40}P_{40}$ and $N_{80}P_{80}$ fertilizers doses determined very high mobile phosphorus content values (95-97 mg/kg). Mobile potassium contents in the analyzed variants are low ((100-125 mg/kg). Grain yield ranged from 1,483 to 2,053 kg/ha. The lowest yield resulted in the unfertilized and unlimed control. The highest values of grain yield were obtained when applying liming doses together with complex fertilizers.

***Key words**: chalking, chemical fertilizers, acid soils, soy*

INTRODUCTION

Acid soils that can be limed occupy a 3.424 million ha in our Country of which almost 2 million ha have cultivable use and are mainly represented by pedological units of the Luvisols (for agricultural areas) and Cambisols (Dystric Cambisols; in mountainous areas) classes. The total acid soils area that can be limed can be completed and extended to other pedological units too which are acidified technologically or by pollution at the same level.

The needed chalking doses in our Country, according to the basic soils acidity indices, are 4-6 t/ha (materials with calcium carbonate, $CaCO_3$) or 1-2 t/ha (materials with calcium oxide, CaO). Experiments and production practice proved that a good chalking for acid soils must have a neutralizing capacity (%$CaCO_3$) as high as possible, as a general rule 70-90%, some residual fertilizing elements in its composition, a good physical condition (size reduction without humidity), good solubility, rapid and sustainable effect.

Chalking assortment for the acid soils of our Country easy to supply are: calcium carbonate ($CaCO_3$) with residual nitrogen (N), calcium carbonate of grinded limestone, dolomite ($CaCO_3 \cdot MgCO_3$) with a 70-90% $CaCO_3$ content, and Terracalco (with calcium oxide and 120-180% neutralizing power).

Chalking doses computed for neutralizing 75-100% Ah or achieving a 75%, even 75-

90%, base saturation (V) accomplish an acid soils reaction correction effect of minimum 4-5 years and even 6-8 years, with the maximum acidity neutralization effect in the years 2-3 from liming. Another 2-3 years from the maximum effect the acidity and base saturation indices are limited, the improving effect is reduced, and after 6-8 years it is necessary to intervene to re-lime these soils (at the moment when the reference indices fall-back to the values at which the initial decision was taken to lime) (Lăcătușu, 2006).

Three stringency steps have been set depending on acidity intensity, base saturation degree, and soil texture, as follows:

❖ stringency I: acid soils with the aqueous suspension pH below 5.0 and V% <50;

❖ stringency II: acid soils with pH between 5.0 and 5.6; V% = 50-70 for sandy-loamy soils and V% = 75 for clayey and clayey-loamy soils;

❖ stringency III: soils with pH between 5.6 and 5.8, V% from 75 to 85, and clayey-loamy texture; soils with pH between 5.6 and 6.0, V% = 70-80, and sandy-loamy texture (Borlan et. al., 1982).

The main condition a chalking must have is its neutralizing power. This is expressed as % in relation to pure calcium carbonate ($CaCO_3$) and must be as high as possible so that no large chalking quantities be needed (Lăcătușu, 2016).

The acid soils that can be limed and those that are already limed are mainly interesting in complex fertilizations (primarily with basic NPK, NPK+ applications and also NP and NP+) and additional ones (N, NP), all in doses depending on the soil initial nutrients supply and the cultivated genotype needs according to its specific nutritive intake. Long term experiments at SCDA Livada and Albota, and in other conditions too, with different fertilizations integrated in the acid soils chalking conditions proved over the years that the economically optimum doses range at active substance (a.s.)/ha values of 100-120 kg for nitrogen (N), 50-70 kg for P_2O_5, 80-120 kg for K_2O, depending on the cultivated genus too, and also different doses of magnesium (Mg), sulphur (S), and micro-elements: manganese (Mn), iron (Fe), copper (Cu), zinc (Zn), boron (B) as their chemism can be disrupted due to the radical pH changes towards the slightly alkaline range and calcium better represented in the cations structure (Agrim, Cluj Napoca, 2021).

Organic and mineral fertilization of limed soils contributes to obtaining significant yield gains due to the nutritive elements input and the amelioration of the physical an biological conditions (Lăcătușu, 2002). It must be known though that simultaneous administration of chalking and ammonium containing mineral fertilizers is not recommended because reactions occur that lead to ammonia (NH_3) losses. Alike concomitant application of calcium carbonate and superphosphate or phosphorites is not recommended because the alkaline environment determines monocalcium phosphate insolubilization forming tricalcium phosphate (Lăcătușu, 1973a). But urea, potassium nitrate and sulphate, potassium salt can be administered at the same time with the calcium carbonate (Hera, 1980). Nitrogen presence and less that of phosphorus ensures a better efficiency as acid soils also have low fertility caused by the scarce presence of nutrition elements. It is proven thus that the rectification effect through acidity neutralization along with the fertilization one act by potentiating the results of these soils improvement and the achievement of higher yields (Vidican et. al., 2013).

MATERIALS AND METHODS

Soil was sampled on a 0-20 cm depth.

In the laboratory phase the soil samples were conditioned by drying, grinding, and preparing them for analyses: organic remainders and coarse fragments are eliminated in compliance with SR ISO 11464:1998. Dedicated and standardized analytical methodology usually practiced in the ICPA Bucharest laboratories was used for the soil samples chemical analyses, as follows:

- organic matter (humus): volumetric determination by the wet oxidation method after Walkley Black modified by Gogoaşă – STAS 7184/21-82;
- pH: potentiometric determination with glass and calomel combined electrode in aqueous suspension in a 1:2.5 soil:water ratio – SR7184/13-2001;
- total nitrogen (N%): Kjeldahl method, digestion with concentrated sulphuric acid (H_2SO_4) at 350°C, potassium sulphate and copper sulphate catalyst – SR ISO 11261:2000;
- soluble phosphorus and potassium in the ammonium acetate lactate solution at pH 3.7 (after Ègner-Riehm-Domingo) were determined by UV-VIS spectrometry (P) and flame photometry (K);
- SB – the sum of basic cations was determined by the Kappen method, extraction in a 0.05 *n* HCl solution, STAS 7184/12-88; 2.2.2. (me/100 g soil);
- Ah – hydrolytic acidity was extracted in a 1 *n* natrium acetate solution at equilibrium, with a 1:2.5 soil:solution ratio and titrated with NaOH in the presence of phenolphthalein – STAS 7184/12-88; 2.4. (me/100 g soil).
- V_{Ah} – the base saturation degree was computed;
- T_(NH_4) total cationic exchange capacity – STAS 7184/12; 2.6.2 - var.2; 3.2.1.

RESULTS AND DISCUSSIONS

Soil reaction (pH) is strongly acid in the unfertilized control N_0P_0. Differences occur when applying $N_{40}P_{40}$ and $N_{80}P_{80}$ fertilizers doses, with 4.64-4.72 values. When applying powder Agrocalcium chalking 2.5 t/ha with different fertilizers doses pH value increased up to 4.9. Powder and granules Doloflor application without fertilization modified pH values to 5.3-5.5, a moderately acid reaction (Figure 1.).

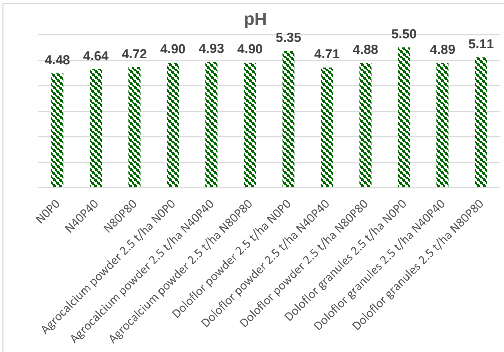

Figure 1. The SCDA Albota Albic Luvisol’s reaction after chalking and fertilizers application

Acidity below pH 5.8 affects plants growth and nutrition. Below pH 5.5 essential micro elements availability is significantly diminished in many cases and the growth and evolution of plants such as peas, bean, sun flower, barley, alfalfa, etc. are strongly affected. The humus content is low, with values spanning between 2.0 and 2.5% in all the analyzed variants (Figure 2). Limed and re-limed acid soils fertilization is a mandatory measure to add to reaction adjustment because acid soils that can be limed are characterized by a precarious supply of nutritive elements and humus on one hand and on the other it has been proven by experiments and practice that there is a positive interaction and a mutual potentiation between the liming and fertilization measures.

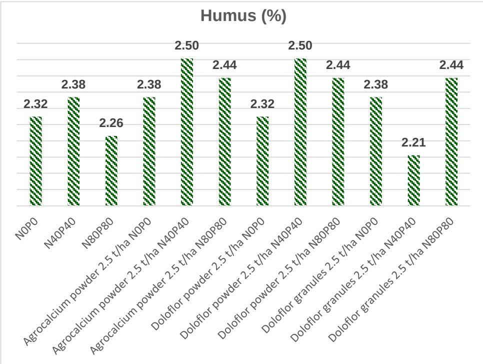

Figure 2. Humus content of the SCDA Albota Albic Luvisol after chalking and fertilizers application

The nitrogen (N%) content is low, with values ranging from 0.119 to 0.125% in all the experimental variants analyzed (Figure 3).

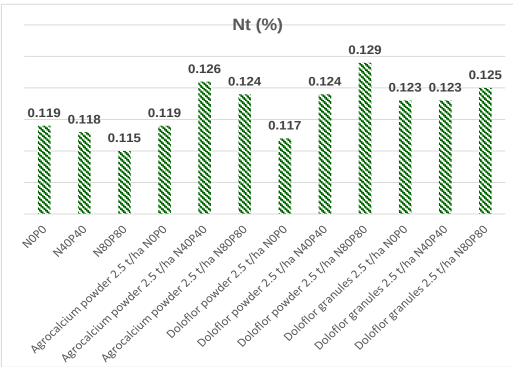

Figure 3. Nitrogen content of the SCDA Albota Albic Luvisol after chalking and fertilizers application

The mobile phosphorus content (P_{AL}, mg/kg) in the unfertilized control is 51 mg/kg (Figure 4).

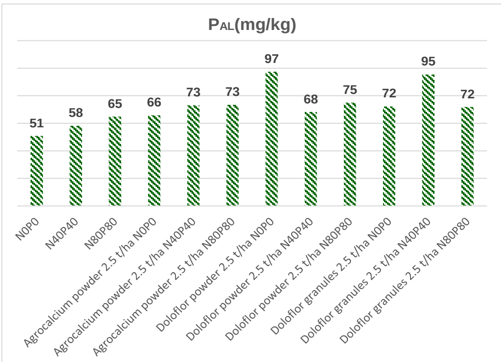

Figure 4. Mobile phosphorus content of the SCDA Albota Albic Luvisol after chalking and fertilizers application

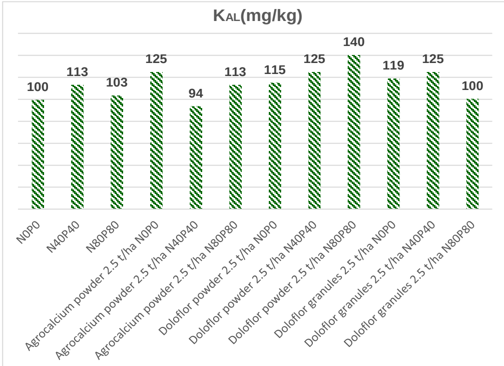

Figure 5. Mobile potassium content of the SCDA Albota Albic Luvisol after chalking and fertilizers application

It grows following the application of 2.5 t/ha Agrocalcium chalking powder and fertilization with the two fertilizer doses $N_{40}P_{40}$ and $N_{80}P_{80}$ to values between 66 an 73 mg/kg. Application of 2.5 t/ha Doloflor chalking, powder and granules, together with the $N_{40}P_{40}$ and $N_{80}P_{80}$ doses registered very high values (95-97 mg/kg).

Mobile potassium content in the analyzed variants is low (100-125 mg/kg) (Figure 5).

When deciding on fertilizers assortment (mainly mineral) it is essential that the chosen fertilizer support the neutralizing effect of the applied chalking and not alter the reaction through secondary acidification effects. The assortments of fertilizers of the nitrogen (N) class – urea, calcium ammonium nitrate, UAN – or of the phosphorus (P) class – superphosphate have positive effects as do many complex fertilizers.

The sum of exchangeable bases (SB) is low-medium with values ranging from 12.61 to 19.51 mg/100 f soil (Figure 6).

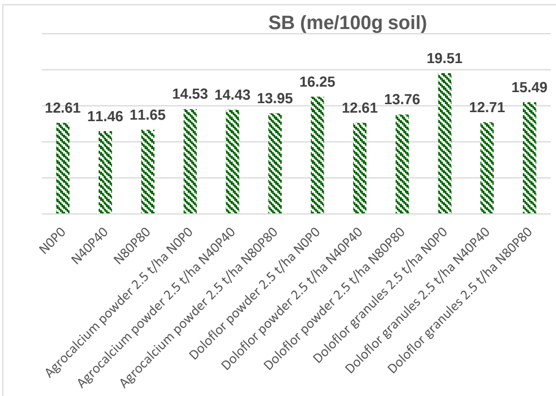

Figure 6. Sum of exchangeable bases of the SCDA Albota Albic Luvisol after chalking and fertilizers application

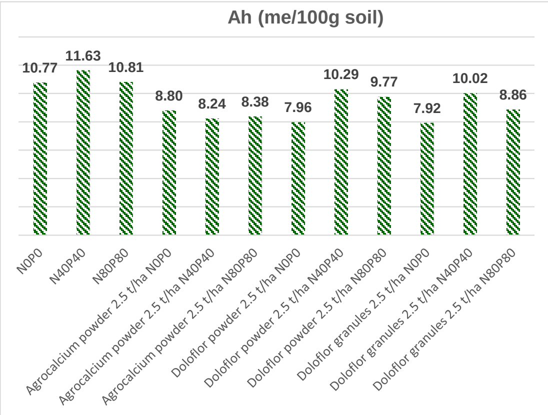

Figure 7. The hydrolytic acidity of the SCDA Albota Albic Luvisol after chalking and fertilizers application

The hydrolytic acidity (Ah) is very high (($\geq$ 8.1, Figure 7) in all the analyzed variants. The base exchange capacity (T) varies from 22.34 to 27.43 me/100 g soil (Figure 8). The soil is oligomesobasic in all the variants, with the base saturation degree 55.1-67.1%.

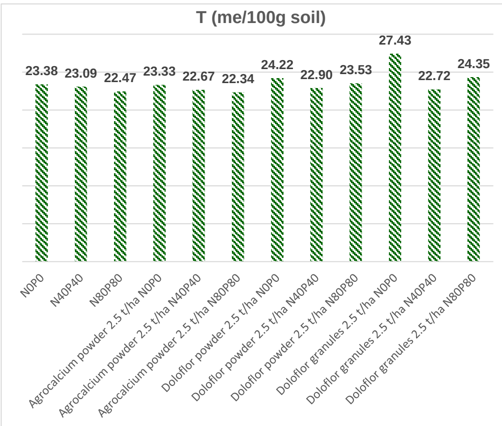

Figure 8. Base exchange capacity (T, me/100 g soil) of the SCDA Albota Albic Luvisol after chalking and fertilizers application

Liming is economically justified at pH_{H_2O} values below 5.8 and base saturation degree below 75% (Figure 9). Acid soils re-liming must be done as soon as the mentioned agrochemical indices fall-back to the values that show liming appropriateness because of the wide variation of the liming effects duration, determined by the chalking dose, soil properties and its use, nitrogen fertilization intensity.Soils acidification was intensified anthropically following non-balanced fertilization, especially with nitrogen fertilizers, acid atmospheric depositions (acid rains) loaded with different emissions of industrial equipment or by spreading potentially acid substances on soil. Soy plants biomass was relatively consistent, ranging from 4,720 to 5,833 kg/ha.

Pods yield on area unit was between 2,780 and 3,760 kg/ha for the analyzed variants. Pods represented between 58.3 and 65.9% of the total soy biomass.

Soybean yield was between 1,483 and 2,053 kg/ha. The lowest yield was obtained in the unfertilized and unlimed control. The highest soybean yield values corresponded to chalking doses applied together with complex fertilizers. As for the percentage of the beans out of the total biomass it ranged between 29.5 and 38.9%. Most of the values outran 30% which represents particularly good percentages in the conditions in which the soy plants grew and developed. Clear influences of the chalking input to the beneficial substrate the plants took advantage of were noticed in the case of beans percentage out of the total biomass too. The values of one thousand beans mass, characteristic for this breed grown in droughty conditions, were considered good. The long droughty time, especially after blooming and also in the beginning of beans development constituted an undesirable effect. The one thousand beans mass values ranged from 111 to 128 g over the whole experiment. Values were increasing in the variants treated with only Agrocalcium and Doloflor as compared to the unlimed control. The very good effectiveness of the Cemrom-type chalking was proven in plants vegetation. The values of the controls treated with only chalking were gradually outrun by the combinations with chemical and organic and mineral fertilizers which were the most favorable.

CONCLUSIONS

Doloflor chalking applied as powder and granules in 2.5 t/ha dose without N and P

fertilization modified pH values to 5.3-5.5, a moderately acid reaction.
Humus content is low, with values ranging from 2.0 to 2.5%. Powdered Doloflor chalking and granules 2.5 t/ha each together with $N_{40}P_{40}$ and $N_{80}P_{80}$ registered very high values (95-87 mg/kg) of the mobile phosphorus content.
Mobile potassium content in the analyzed variants is low (100-125 mg/kg).
Soy plants biomass was relatively consistent, ranging from 4,720 to 5,833 kg/ha. The highest levels were obtained with all the three used fertilizer types.
Pods yield ranged between 2,.780 and 3,760 kg/ha in the analyzed variants. Pods represented 58.3-65.9% of the total soy biomass.
Beans yield ranged from 1,483 to 2,053 kg/ha. The unfertilized and unlimed control yielded the lowest.
The highest beans yield values were obtained by applying chalking doses together with complex fertilizers.

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