Scientific Papers. Series A. Agronomy, Vol. LXVII, No. 2, 2024
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

METHODS OF REMEDIATION OF SALINE SOILS IN LONG-TERM EXPERIENCES AND THROUGH RICE CULTIVATION AT ARDS BRAILA

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Abstract

The paper presents results of some long-term experiences at the Braila Agricultural Development Research Station, with different mineral and organic fertilizers, as well as through rice cultivation. Through agrochemical analyses of the soil as well as through the analysis of the productions, it was found that the optimization of the fertilization system can be done both by the method and by the time of application, which are factors for increasing the efficiency of the fertilizing elements and the economy of fertilizers. The localized application of a small amount of N23P23 or N13P26K13 kg/ha s.a. fertilizers, the so-called starter fertilization, determined the increase in the efficiency of the use of fertilizers for all fertilizing elements. Thus, for phosphorus at equivalent doses, production increases of up to 18% were achieved, for nitrogen up to 5% and for potassium up to 4%. Also, rice cultivation has proven to be the fastest and most effective method of improving and capitalizing on saline soils, especially under the conditions of climate change.

Key words: *soil salinization, rice, crops.*

INTRODUCTION

The soil is the basis of the existence of terrestrial life (Hera, 2016), and represents 29% of the Earth's surface, of which only 6.4% is intended for agriculture. However, food production is carried out predominantly on this surface, i.e. in a percentage of 95%, while only 5% food production is carried out on the 71% of the surface covered by water. That is why it is very important to preserve soil fertility through conservative technologies, no matter how much one would like to increase production per hectare.

To satisfy the ever-increasing need for food and in the conditions where the agricultural land surfaces are reduced year by year, and their fertility is substantially degraded, it is essential to increase the productions per surface unit through technological methods continuously adapted to the climatic conditions and through maintaining soil fertility.

The long-term experiences with fertilizers can ensure an efficiency of the consumption of fertilizers to obtain superior agricultural productions from a quantitative and qualitative point of view.

It was found that the doses of fertilizers applied to obtain maximum or economically optimal productions fluctuate widely, from year to year, depending on the climatic conditions (Hera, 1972; Hera and Borlan, 1975).

Salinity has affected almost 1,000 million hectares of land, of which approximately 77 million hectares are cultivated. Globally it reached 19.5% and 2.1% respectively in irrigated and non-irrigated fields. At the same time, the current population is approximately 7.7 billion inhabitants, and by 2020 it is estimated that it will increase to approx. 8 billion, which will further worsen food security (Asharf, 2009; https://www.worldometers.info/ro/).

Salinity is a major abiotic stress originating from irrigation sources and groundwater. Thus, salinity reduces plant growth and development, yield of sensitive crops by inducing physiological dysfunction (Shannon et al., 1994; Khan and Panda, 2008). The harmful effects of salinity are associated with water deficit, ionic imbalance, mineral nutrition, stomatal behaviour, and the efficiency of the photosynthesis process (Bohnert et al., 1995).

Thus, salinity has come to affect almost every aspect of plant physiology and biochemistry (Khan et al., 2002). All soils contain a wide range of soluble salts, some of which are essential for plant growth and development. Thus, Ca^{2+}, Mg^{2+} and Na^{+} are the most common cations, and Cl^{-}, SO_4^{2-} and HCO_3^{-} are the anions associated with soil salinity.

Jacoby (1999) stated that for saline environments, NaCl is the most important constituent, and Tucker (1999) says that Na^{+} and Cl^{-} are considered necessary for some plants, for example, salt-tolerant plants.

Exposure of plants to salinity can cause several changes, morphologically, physiologically, and biochemically, due to excessive ions and deficient water (Maskri et al., 2010).

In various research, a change was observed in the growth processes, photosynthesis, and protein synthesis, but also in lipid metabolism (Parida and Das, 2004); high concentrations of salts in plants generate changes related to plant productivity (Hasegawa et al., 2000), nutritional imbalances (Ashraf, 2009), as well as the accumulation of osmotic protective compounds (proline).

Occupying just over 15% of the world's arable surface, rice (*Oryza sativa* L.) is one of the most important agricultural crops in the world and represents the basic food for Asia and Africa, given that Asia produces and consumes over 90% of the global amount of rice. FAO Statistics shows that rice feeds 2/3 of the world's population (over 66%).

Simplifying the technology and making each element more efficient can lead to impressive economic results. Rice could become a representative crop for Romania and for dry areas that have water resources for irrigation, including areas with saline soils. The technology of rice cultivation and flood irrigation, associated with the 3-year rotation, could solve the problem of salinized soils in a natural way and without additional expenses. Romania is at the Northern limit of rice cultivation in Europe. The purpose of introducing and maintaining rice in culture was to cover the needs for current consumption, from the national production.

MATERIALS AND METHODS

The long-term experiments with fertilizers carried out at SCDA Braila were in the three experimental centres (Chiscani, Silistraru and IMB), for two research directions:

- evaluation of NP interaction and the effect on crops and indicators within the soil-plant system;
- evaluation of the effect of organo-mineral fertilization, by applying manure in interaction with NPK mineral fertilizers, on crops and the evolution of soil fertility indicators.

Thus, it was possible to study the evolution of production yields, in different agricultural conditions, with the aim of elaborating the basis for the scientific substantiation of the application of organo-mineral fertilizers to different agricultural crops.

The following aspects were analysed:

- the average productions obtained under the influence of the application of different doses of NP fertilization;
- the average effect of nitrogen application on production;
- the average effect of phosphorus application on production;
- the effect of applying different doses of nitrogen on the agrochemical indices of the soil;
- the effect of applying different doses of phosphorus on the agrochemical indices of the soil;
- average results regarding the export of NPK in grains;
- the effect of applying different doses of fractionated and unfractionated fertilizers to the corn crop.

Also, the improvement of the elements of rice cultivation technology and the introduction of the 3-year rotation led to a decrease in soil salinity and an increase in soil fertility indices.

RESULTS AND DISCUSSIONS

The average productions obtained in soybean fell between the values of 2660 kg/ha at N30P0 and 3220 kg/ha at N120P40, the fertilization effect being maximum at doses of 120 kg/ha N s.a. and 40 kg/ha P_2O_5 (Figure 1).

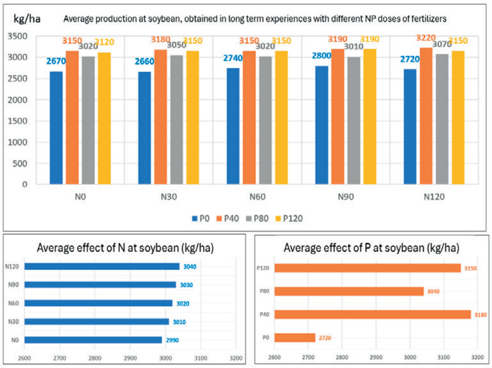

Figure 1. The graphs with average effect
of different doses of NP fertilizers

Regarding the influence of fertilization with different doses of nitrogen and phosphorus on the soybean crop, it was found that fertilization with a dose of 120 kg s.a. of phosphorus increases most of the soil fertility indices, while the increase of the nitrogen dose in the soybean crop did not have a significant influence on the other indices (Figures 2, 3).

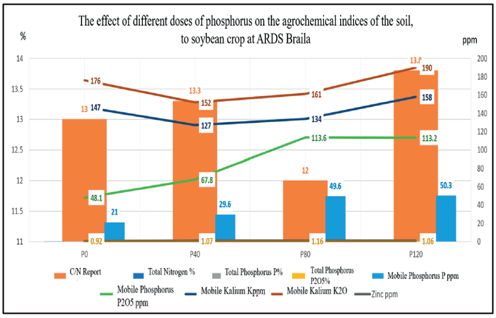

Figure 2. The effect of different doses of phosphorus
on the agrochemical indices of the soil,
to soybean crop at ARDS Braila

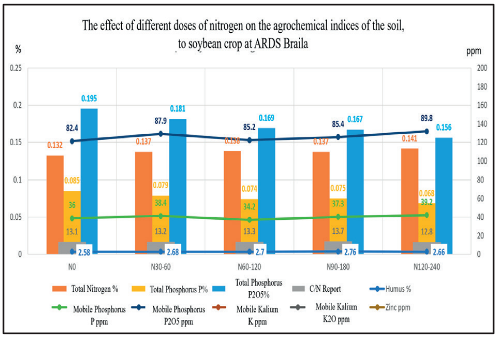

Figure 3. The effect of different doses of nitrogen
on the agrochemical indices of the soil,
to soybean crop at ARDS Braila

For a more detailed analysis of the influence of long-term fertilization with NP, the average results regarding the export of NPK in soybean and corn crops were analysed, both by analysing the percentage content in grains and by calculating the export of active substance in kg/ ha. The statistical data highlighted the fact that when fertilizing with different doses of phosphorus, the highest percentage content of nitrogen and kalium in grains was recorded when fertilizing with phosphorus at a dose of 80 kg s.a./ha, and for the content of phosphorus in grains, the best result was when fertilizing with P40 (Figure 4).

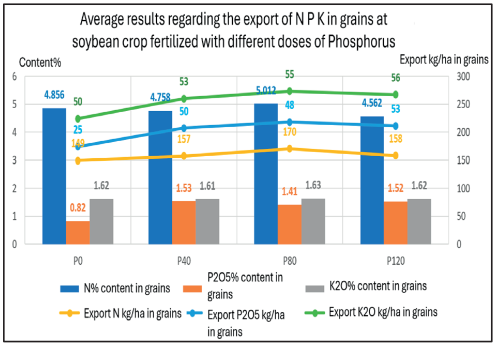

Figure 4. The effect of Phosphorus fertilization on N P K
export in grains soybean at ARDS Braila

Regarding fertilization with different doses of nitrogen, the highest export of nutrients in grains was recorded at the dose of 120-240 kg/ha, both for nitrogen (170 kg s.a./ha) and for phosphorus (46 kg s.a./ha) and potassium (54 kg s.a./ha) (Figure 5).

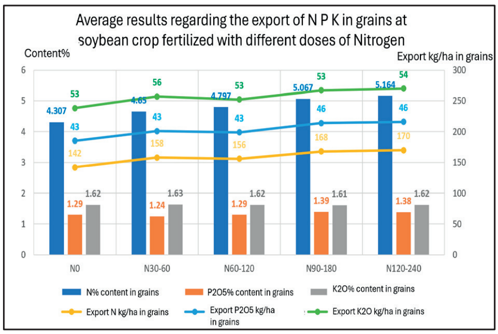

Figure 5. The effect of Nitrogen fertilization on N P K
export in grains soybean at ARDS Braila

The average productions obtained in the long-term corn experiments at the Chiscani experimental centre were between the value of 7510 kg/ha for the control variant (N0P0) and 11720 kg/ha for the N180P80 variant (Figure 6).

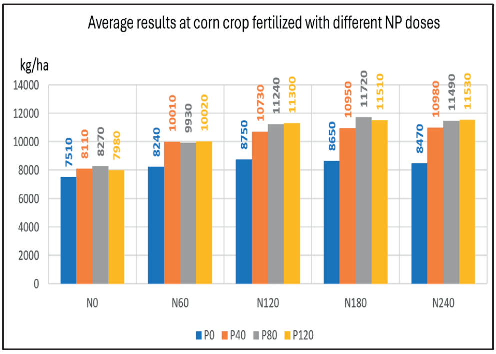

Figure 6. The graph of absolute average productions compared to the untreated control in the corn crop

The calculation of the percentage differences in corn production, compared to the untreated control, showed that the best results were obtained, in descending order, by the variants N180, N240 and N120 in combination with P80 (Figure 7).

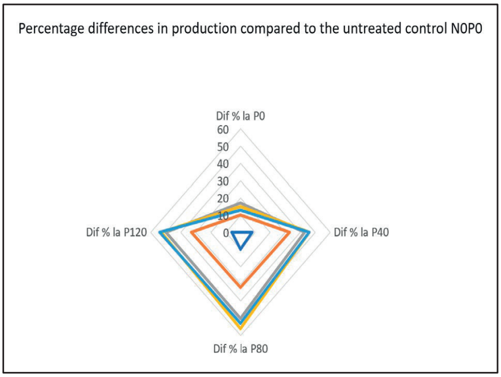

Figure 7. The graph of average absolute and percentage productions compared to the untreated control in the corn crop, at SCDA Braila

The average effect of nitrogen fertilization on production was the most increased in the corn crops at the dose of 180 kg/ha N s.a. with 80 kg/ha P s.a., followed in descending order by the dose of 240 kg/ha N s.a. with 120 kg/ha P s.a., and 120 kg/ha N s.a. with 40 kg/ha P s.a. (Figures 8, 9).

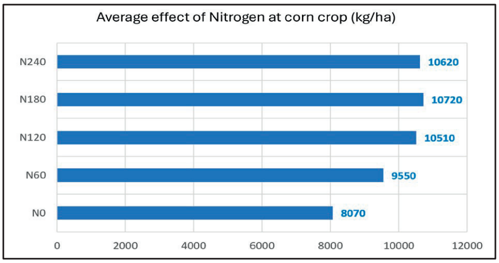

Figure 8. The graphs of average effect of Nitrogen fertilization at corn crop

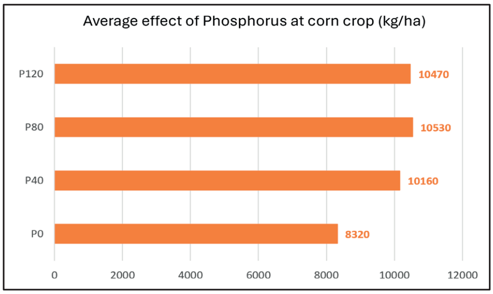

Figure 9. The graphs of average effect of Phosphorus fertilization at corn crop

The export of N P K macro elements in grain production was the highest when fertilized with P40-P80 and N120-N180, with N export values in grains between 113 kg/ha when fertilized with P40 and 115 kg/ha when fertilized with N120, followed in descending order by the export of P in grains between 69 kg/ha P2O5, when fertilized with P80 and 65 kg/ha when fertilized with N180 and N240, then by the export of K of 39 kg/ha K2O, when fertilized with N240 and 38 kg/ha K2O, when fertilized with P80-120 (Figures 10, 11).

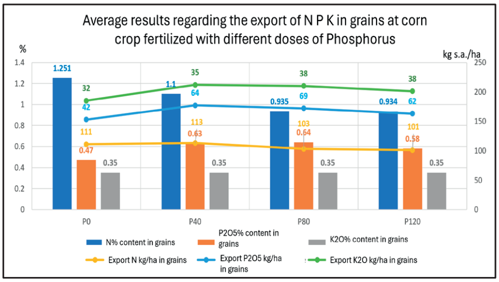

Figure 10. The effect of Phosphorus fertilization on NPK export in grains soybean at ARDS Braila

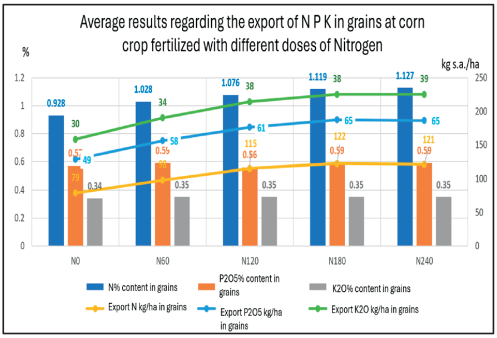

Figure 11. The effect of Nitrogen fertilization on NPK export in grains soybean at ARDS Braila

Regarding the effect of fertilization with nitrogen and phosphorus in long-term experiments, on the agrochemical indices of the soil, significant increases in the content of nitrogen, phosphorus and potassium were observed when applying the dose of 120 kg/ha P s.a. and 60 kg/ha N s.a., but the humus content was not influenced by the increase in the doses of chemical fertilizers (Figures 12, 13).

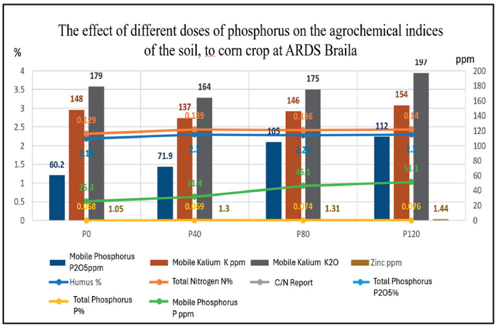

Figure 12. The average effect of chemical fertilization with phosphorus in long-term experiments, on the agrochemical indices of the soil, at ARDS Braila

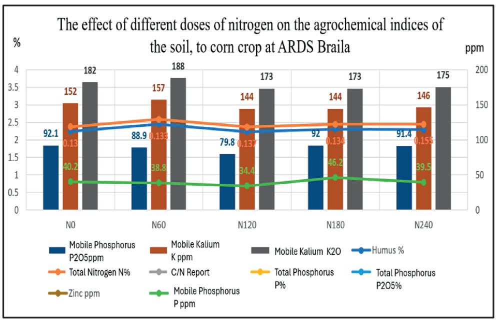

Figure 13. The average effect of chemical fertilization with nitrogen in long-term experiments, on the agrochemical indices of the soil, at ARDS Braila

In rice cultivation, the most important technology is on the plots with laser-guided machines, which ensure a very good levelling and a deviation from the average elevation of +/- 2-3 cm.
Therefore, the levelling creates possibilities to reduce the production cost through the economy due to the decrease in the thickness of the irrigation water layer. At the same time, the possibility of increasing the yields of the rice plots is created.
At the same time, merging the rice plots, by eliminating the ridges and bringing them to a level of 10 cm, the plots can be merged up to 4-8 hectares, and the application of crop rotation thus becomes more economically profitable.
Intelligent pumping systems, with minimal maintenance needs, sensors, and remote controls, can reduce electricity costs by 50% per total irrigation season.
The practice of crop rotation in rice cultivation technology has shown that production increases by 41% compared to monoculture rice. At the same time, the monoculture of rice affects the fertility of the soil and increases the maintenance cost of the crop.

CONCLUSIONS

The production increase in agricultural crops is conditioned by the application of mineral and organic fertilizers, in accordance with the pedological conditions and the specific consumption of the plants.
The protection, resilience and increase of soil fertility is done through a correct and rational application of fertilizers, to ensure the necessary plant production, but also to increase soil fertility.
In long-term experiences with mineral fertilizers, there is a tendency to reduce the content of C-organic, N-organic and humus, which is why the periodic use of organic fertilizers is recommended, C+NPK fertilization systems being much more sustainable (organic + NPK) than only NP or NPK.
Considering the current inflationary situation and the war in the neighbourhood, which will continue to have a negative impact on Romania's agriculture, the fertilization plan must be simplified, complying with the standard of the maximum amounts of nitrogen (170 kg/ha s.a.)

that can be applied on agricultural land and to ensure a uniform distribution of fertilizers on the land, to maintain soil fertility.

The calculation of the doses of fertilizers must be done correctly, both for economic reasons and for environmental protection requirements, the forecasted production must be realistic, considering both the local pedoclimatic conditions and the productive potential of the cultivated varieties and hybrids.

Currently, through the introduction of digital technologies in the agricultural field, which allow the scanning of lands with the help of satellites and drones, the application of fertilizers can be done variably, so that the crops grow uniformly over the entire surface, and the productions are increased and uniform, and the fertility of the soil to be durable.

ACKNOWLEDGEMENTS

This research work was carried out with the support of Ministry of Agriculture and Rural Development Romania, by Sectorial Plan ADER 2026, and was financed from the project: "Measures and recommendations for reducing the risk of salinization and soil erosion under the influence of climate change" – Contract No. ADER 20.1.3./17.07.2023.

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