TESTING OF THE FRIT PRODUCT WITH CONTROLLED EMISSION OF PHOSPHORUS AND MICROELEMENTS

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RESEARCH ARTICLE

Abstract
The study presents the experimental results obtained in corn cultivation by applying a new set of phosphorus fertilizers based on frit. These fertilizers provide macronutrients PK in different proportions, as well as micronutrients. Fractional application of frit fertilizers (as an additional application to the basic fertilization) allows for the correction and improvement of plant nutrition throughout the growing season.
The application of this set of fertilizers to corn in the greenhouse led to an increase in dry matter production and ensured an increase in PK accumulation in the dry matter of plants.

Keywords: phosphorus, frit, micronutrients.
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INTRODUCTION

Phosphorus is an essential element for plant growth and development, playing an important role in energy transfer, photosynthesis, and shoot and root development (Bechmann et al., 2005; Lambers, 2021; Poirier et al., 2022; Sharma et al., 2018). P availability in soil is low due to the high absorption capacity of soil particles, which makes it less accessible to plants, especially under cold or drought conditions (Frossard et al., 2000; Liu et al., 2024; Zhu et al., 2018). Europe, Romania and Norway rely on imported phosphate rock, which is a non-renewable and expensive resource in the context of a global crisis (Bechmann et al., 2007; Mew et al., 2019; Soesoo and Kirsimäe, 2020). Current research is studying alternative sources of P, such as biochar or frit, to address these challenges. Agricultural soils poorly supplied with phosphorus occupy significant areas in Romania, estimated at approximately 6.3 million hectares. The vast majority of these soils belong to the luvisol class (preluvolsols, luvosols, allosols) whose share was estimated at 25.5% of the total soil resources of Romania. Starting from the need to improve plant nutrition with phosphorus on these soils and from the principle of increasing the degree of utilization of phosphorus from fertilizers, in our country, special importance was given to the production and diversification of the assortment of phosphate chemical fertilizers (Chereji et al, 2022, Chiurciu et al., 2024, 2025; Dana et al., 2024, 2025).

This paper presents the results of some research testing the products, made on the basis of phosphate frit, with controlled emission of phosphorus and microelements.

MATERIAL AND METHOD

Based on the scientific research contract concluded between RISSA Bucharest and S.C. CERASIL SA Oradea, research was organized to test the frits product with controlled emission of microelements FRN 103 and the foliar fertilizer based on phosphate frit with chelated microelements. The testing activity of the frits product range was carried out in the RISSA greenhouse. The experiments were placed in Mitscherlich-type vegetation pots into which 9 kg of soil were introduced. The soil material used came from the surface horizon of the albic luvosol from Albota.

In pots (except for controls) a common fertilization fund of 100 mg N, 50 mg P_2O_5, 50 mg K_2O/kg soil was created, using the fertilizers: urea, simple superphosphate and potassium sulfate.

Frits products were applied in different doses so as to complete the fertilization with phosphorus up to 100 mg P_2O_5/kg soil (Table 1). Control variant I had a fertilization of 100 mg N, 50 mg P_2O_5, 50 mg K_2O/kg soil, and control variant II had a fertilization of 100 mg N, 100 mg P_2O_5, 50 mg K_2O/kg soil. In both control variants, the fertilization was made with chemical fertilizers. Chemical fertilizers and frits products were administered when setting up the experiment. The foliar product Cerasil was applied in concentrations of 0.5-1% three times during the plants' vegetation period. The test plant used was corn, hybrid F322. Soil, plant and fertilizer analyses were performed according to the RISSA methodology.

Table 1

Chemical composition of CERASIL products
Source: own determination, RISSA Contract

Active substance type, %	Cerasil 10/5	Cerasil 10/15	Cerasil 13/5	Cerasil 13/10
P_2O_5	24.38	23.35	22.90	24.38
K_2O	0.45	0.90	0.45	0.60

RESULTS AND DISCUSSIONS

Soil results

Table 2 presents the analytical data characterizing the type of soil albic luvosol (from SCDA Albota-Pitești) used as a culture medium for corn in the greenhouse.

Table 2

Analytical data for the characterization of the albic luvosol
Source: own determination, RISSA Contract

Chemical indicator	UM	Values
pH	-	4.70
Humus	%	1.67
SB	me/100g sol	10.58
Ah	me/100g sol	7.88
T	me/100g sol	18.46
Nt	%	0.092
P_{AL}	ppm	27
K_{AL}	ppm	94
Cu	ppm	0.72
Zn	ppm	1.78
Fe	ppm	28.77
Mn	ppm	54.34

Table 3 presents the analytical data regarding the agrochemical evolution of the soil after 90 days from application under corn crop.

Although the period from incorporation into the soil was short and the elements in the frit are released slowly, some changes in the values were recorded that highlight the positive fertilizing effect of the frit.

Table 3

Analytical data characterizing the agrochemical evolution of the soil after applying treatments to the soil and plants
Source: own determination, RISSA Contract

Treatment variants	Chemical indicator						
	pH	P_{AL} ppm	K_{AL} ppm	Cu ppm	Zn ppm	Fe ppm	Mn ppm
Control I N100 P_2O_5 50 K_2O 50	5.10	48.4	57	1	1.6	46.0	56
Control II N100 P_2O_5 100 K_2O 50	5.00	60.4	54	1	1.9	48.8	60
CERASIL 10/5% + N100 P_2O_5 50 K_2O 50	5.00	57.6	57	1	1.9	50.0	64
CERASIL *10/15%* + N100 P_2O_5 50 K_2O 50	5.00	74.4	62	1	1.9	47.6	60
CERASIL 13/10 % + N100 P_2O_5 50 K_2O 50	5.00	57.6	54	1	2.3	48.4	56
CERASIL 13/5% + N100 P_2O_5 50 K_2O 50	4.80	57.6	58	1	2	51.0	64
FRIT FRN 103 + N100 P_2O_5 50 K_2O 50	5.20	56.0	66	1	2.4	48.4	56
CERASIL 10/5%	4.90	54.4	42	1	1.7	50.0	66
CERASIL foliar 0.5%+ N100 P_2O_5 50 K_2O 50	5.00	46.4	50	1	1.8	50.0	56
CERASIL foliar 1.0%+ N100 P_2O_5 50 K_2O 50	5.00	43.0	50	1	1.7	51.0	60

Plant results

The increases in dry plant mass production are listed in Table 4. Compared to the reference variants (M1 and frit applied alone), large increases in plant mass were achieved in all frit variants both at the first harvest (4-6 leaf phase) and at the second harvest-the phase preceding panicle emergence.

Tables 5-6 present the contents of phosphorus, potassium and microelements in corn plants at the two harvests.

The analytical data highlight a positive influence on the dynamics of the elements in the plant growth process.

Table 4 presents the production increases obtained when fertilizing corn with Cerasil foliar fertilizer applied in concentrations of 0.5% and 1%.

With both concentrations, production increases were obtained that correlate with the concentration, but since the testing period was in a single cycle, the differential effectiveness of the two concentrations cannot be quantified (Tables 5-6).

Table 6 presented the influence of Cerasil foliar fertilizer on the phosphorus and potassium content of the plant, after three foliar applications.

The analytical data show a significantly greater difference in the variant in which the 1% concentration was applied.

Table 4

Data on the influence of frit-based fertilizers on the dry mass of corn plants
Source: own determination, RISSA Contract

Treatment variants	Dry weight of plants g/pot	
	Harvest I Phase 4-6 leaves	Harvest II Before panicle emergence
Control I N100 P_2O_5 50 K_2O 50	7.30	60.35
Control II N100 P_2O_5 100 K_2O 50	9.43	62.82
CERASIL 10/5%+N100 P_2O_5 50 K_2O 50	9.63	68.63
CERASIL 10/15%+N100 P_2O_5 50 K_2O 50	11.43	83.09
CERASIL 13/10 %+N100 P_2O_5 50 K_2O 50	9.70	66.83
CERASIL 13/5%+N100 P_2O_5 50 K_2O 50	10.60	77.00
FRIT FRN 103+N100 P_2O_5 50 K_2O 50	10.33	55.13
CERASIL 10/5%	5.20	13.20
CERASIL foliar 0.5%+N100 P_2O_5 50 K_2O 50	11.43	63.53
CERASIL foliar 1.0%+N100 P_2O_5 50 K_2O 50	12.45	65.23
LSD 5%	1.55	6.85
LSD 1%	2.13	9.39

Table 5

Nutrient content of corn plants, in the frit experiment, harvest I, phase 4-6 leaves
Source: own determination, RISSA Contract

Treatment variants	Elements					
	P %	K%	Zn ppm	Cu ppm	Fe ppm	Mn ppm
Control I N100 P_2O_5 50 K_2O50	0.186	2.25	37.96	6.66	84.00	320.66
Control II N100 P_2O_5 100 K_2O 50	0.193	1.94	38.33	6.66	56.66	125.00
CERASIL 10/5%+N100 P_2O_5 50 K_2O 50	0.193	1.93	37.96	5.00	65.00	202.33
CERASIL 10/15%+N100 P_2O_5 50 K_2O 50	0.173	1.84	38.56	7.33	62.33	228.00
CERASIL 13/10 %+N100 P_2O_5 50 K_2O 50	0.200	2.01	37.96	5.00	61.66	175.66
CERASIL 13/5%+N100 P_2O_5 50 K_2O 50	0.260	1.82	36.80	6.66	71.66	114.00
FRIT FRN 103+N100 P_2O_5 50 K_2O 50	0.200	1.70	35.00	10.00	57.00	160.33
CERASIL 10/5%	0.260	1.75	23.33	8.33	58.33	77.00
*CERASIL foliar 0.5%+N100 P_2O_5 50 K_2O 50	0.180	2,06	38.13	7.06	56.16	275.00
*CERASIL foliar 1.0%+N100 P_2O_5 50 K_2O 50	0.170	1.93	33.70	7.03	100.33	462.00
LSD 5%	0.034	0.28	5.49	4.17	32.42	193.40
LSD 1%	0.046	0.39	7.52	5.71	44.43	264.98

*after the first application of foliar fertilizers

Table 6

Nutrient content of corn plants, in the frit experiment, harvest II, before panicle emergence
Source: own determination, RISSA Contract

Treatment variants	Elements					
	P %	K%	Zn ppm	Cu ppm	Fe ppm	Mn ppm
Control I N100 P_2O_5 50 K_2O 50	0.173	0.91	45.00	4.00	79.33	429.33
Control II N100 P_2O_5 100 K_2O 50	0,166	0.85	38.33	6,83	61.00	166.00
CERASIL 10/5%+N100 P_2O_5 50 K_2O 50	0.160	0.82	36.66	3,66	55.00	161.00
CERASIL 10/15%+N100 P_2O_5 50 K_2O 50	0.190	0.93	46.00	8.00	63.33	160.00
CERASIL 13/10 %+N100 P_2O_5 50 K_2O 50	0.186	1.14	37.00	4.00	78.33	132.66
CERASIL 13/5%+N100 P_2O_5 50 K_2O 50	0.313	0.95	37.66	6.00	70.66	150.00
FRIT FRN 103+N100 P_2O_5 50 K_2O 50	0.213	1.21	25.00	8.33	62.00	98.33
CERASIL 10/5%	0.353	1.32	26.00	9.00	62.00	51.00
*CERASIL foliar 0.5%+N100 P_2O_5 50 K_2O 50	0.16	0.91	38.33	6.00	80.00	69.66
*CERASIL foliar 1.0%+N100 P_2O_5 50 K_2O 50	0.73	0.99	28.00	8.00	110.66	481.66
LSD 5%	0.034	0.396	8.67	2.33	19.63	91.08
LSD 1%	0.047	0.543	11.88	3.20	26.89	124.78

*after three applications of foliar fertilizers

CONCLUSIONS

CERASIL products tested on corn resulted in increases in dry matter production compared to both control variants. The highest increases in dry matter production were recorded in the variants treated with CERASIL 10/15 and CERASIL 13/5 products.

CERASIL products ensured positive increases in the P content in the dry matter of corn plants (except for the CERASIL 10/5 and 10/15 variants). The highest increases in the P content in the dry matter of plants were achieved in the CERASIL 13/5 variant at harvest I, phase 4-6 leaves.

The K content in the dry matter of the plants was positively influenced by CERASIL products, only in the phase preceding the appearance of the panicle, the increases recorded being between 0.02 – 0.41 % K, compared to control I.

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