PHYSICAL CHEMISTRY 2018

6th Workshop

SPECIFIC METHODS FOR FOOD SAFETY AND QUALITY

September 27th 2018, Vinča Institute of Nuclear Sciences, Belgrade, Serbia

PROCEEDINGS

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IMPROVEMENT OF Fe, Zn AND Mn BIO-AVAIALBILITY BY FERTILIZATION

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ABSTRACT

The objective of experiment was to determine the influence of different fertilizaers: mineral, organic and biofertilizer to phytic acid, Fe, Zn and Mn accumulation in maize with different grain color. Fe, Zn and Mn concentrations in grain depend on year, while Pphy has low variability. Red maize was characterised with the highest Fe and Zn values, while yellow had the highest Mn value. Fertilization could improve Fe, Zn and Mn accumulation in maize grain, mainly application of biofertilizer or cropping without fertilization, thus underlining importance of low-input technologies.

INTRODUCTION

Besides the high grain yields, contemporary agriculture implies low inputs of agro-chemicals, with increased application of organic and biofertilizers, due to their restorative role for soil fertility and improved grain quality, thus increasing concentration of important nutrients (minerals, vitamins, antioxidants, etc.). It is well-known that bio-fertilizers stimulate plant growth and productivity [1]. They also increase uptake and accumulation of Fe, Mn, Zn and Cu in plant tissues [2]. Further bio-availability of minerals from maize grains during digestion depends on chemical composition of kernel [3; 4]. One of the most important grain constituent that affects absorption of minerals is phytic acid [5; 6]. Due to the low variability and heritability of phytate in maize grain [7] it could be possible to increase potential bio-availabity of minerals from maize grain.

The aim of this study was to determine the influence of different fertilization systems: conventional with mineral fertilizer, organic and biofertilizer to phytic acid, Fe, Zn and Mn accumulation in maize with variously colored grains.

EXPERIMENTAL

Three maize hybrids, with red grain (H1), white grain (H2) and yellow grain (H3) were sown at the second half of April in 2015 and 2016. Three types of fertilizers were applied before sowing: ammonium nitrate - AN (75 N ha^{-1}), biofertilizer (Uniker) - BF (11 l ha^{-1}), organic fertilizer (Humus Vita Stallico) – OF (3 t ha^{-1}), as well as control, without fertilization – C.

After harvesting, grain samples were prepared for chemical analysis. Phytic acid (Pphy) was determined spectrophotometrically [8], while Fe, Zn and Mn were analysed by ICP-OES. Results were presented with

standard deviation (SD). Principal component analysis (PCA) was used for evaluation of interdependence between Pphy, Fe, Zn and Mn.

RESULTS AND DISCUSSION

Meteorological conditions described 2015 as slightly warmer and drier year, than 2016, with drought period present during July.

Table 1. Variations in concentration of phytic acid (Pphy), Fe, Zn and Mn in maize grain (H1 - red grain, H2 - white grain, H3 – yellow grain).

		Pphy (mg g^{-1})	Fe (μg g^{-1})	Zn (μg g^{-1})	Mn (μg g^{-1})
		2015			
H1	AN	2.620 ± 0.031	62.28 ± 2.09	59.22 ± 5.47	14.22 ± 0.656
	BF	2.977 ± 0.015	83.53 ± 0.16	84.81 ± 2.00	13.81 ± 0.062
	OF	2.412 ± 0.096	58.41 ± 0.47	72.78 ± 9.47	13.72 ± 0.281
	C	2.642 ± 0.053	97.19 ± 0.25	86.25 ± 3.81	14.31 ± 0.313
H2	AN	2.474 ± 0.065	35.19 ± 0.75	29.63 ± 3.19	9.66 ± 0.094
	BF	2.028 ± 0.065	38.03 ± 3.59	28.34 ± 2.34	9.19 ± 0.563
	OF	2.189 ± 0.146	54.59 ± 0.78	37.94 ± 4.81	13.50 ± 0.313
	C	2.459 ± 0.192	43.56 ± 0.25	34.94 ± 4.00	10.84 ± 0.281
	Mean	2.288	42.84	32.71	10.80
H3	AN	2.580 ± 0.127	63.47 ± 1.34	65.13 ± 1.19	14.63 ± 0.063
	BF	2.682 ± 0.050	86.06 ± 0.31	92.66 ± 8.59	13.41 ± 0.031
	OF	2.580 ± 0.028	39.54 ± 0.26	66.25 ± 7.38	16.91 ± 0.469
	C	2.484 ± 0.074	47.81 ± 4.69	62.50 ± 0.00	16.25 ± 0.000
	Mean	2.511	59.14	60.04	13.37
		2016			
H1	AN	2.893 ± 0.012	72.44 ± 0.96	43.54 ± 0.00	8.80 ± 0.073
	BF	2.552 ± 0.025	50.21 ± 0.17	47.78 ± 0.12	9.66 ± 0.061
	OF	2.639 ± 0.062	74.13 ± 1.50	44.53 ± 0.08	9.52 ± 0.065
	C	2.871 ± 0.059	63.68 ± 0.80	45.85 ± 0.04	9.33 ± 0.052
H2	AN	2.518 ± 0.059	42.75 ± 0.03	36.72 ± 0.03	7.67 ± 0.080

	BF	2.412 ± 0.015	67.98 ± 0.07	42.32 ± 0.07	8.67 ± 0.025
	OF	2.462 ± 0.022	59.28 ± 0.18	36.49 ± 0.04	7.05 ± 0.005
	C	2.440 ± 0.031	76.76 ± 0.24	39.85 ± 0.11	11.54 ± 0.035
	AN	2.549 ± 0.071	30.73 ± 0.27	29.40 ± 0.00	8.07 ± 0.006
H3	BF	2.552 ± 0.006	44.80 ± 0.02	35.53 ± 0.01	9.40 ± 0.000
	OF	2.403 ± 0.031	40.90 ± 0.08	42.45 ± 0.00	9.16 ± 0.005
	C	2.412 ± 0.053	61.96 ± 0.04	39.48 ± 0.04	9.12 ± 0.008
	Mean	2.559	57.14	40.33	9.00

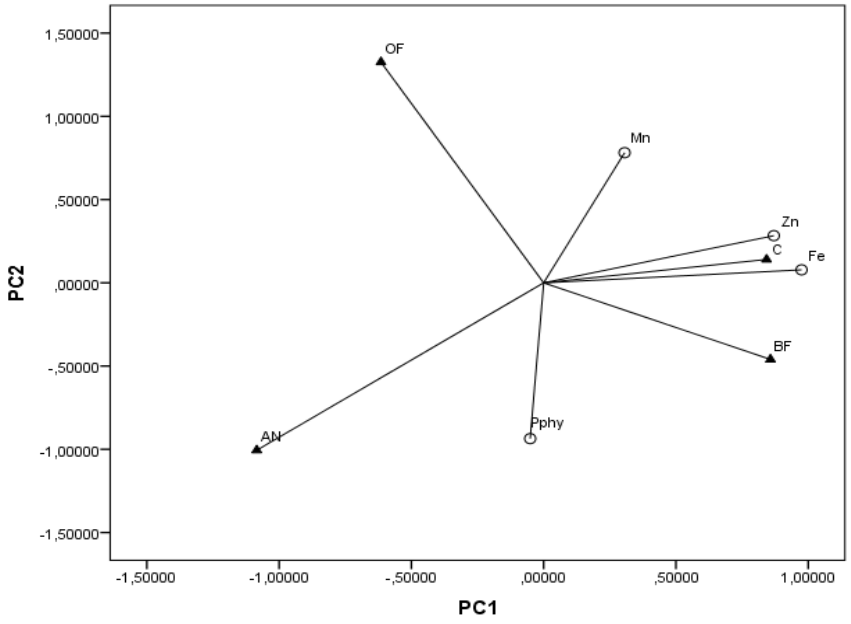

Figure 1. Principal component analysis for phytic acid (Pphy), Fe, Mn and Zn content in maize grain, with applied ammonium nitrate (AN), organic fertilizer (OF), biofertilizer (BF) and control (C)

Differences in meteorological factors affected accumulation of examined parameters in maize grain, with the highest values of Fe, Zn and Mn, and the lower values of Pphy obtained during relatively dry 2015 (Table 1), in comparison to 2016. Phytic acid concentration is genetically driven and from that reason it has low variability [7]. Among hybrids, H1 was characterised with the highest average values of Pphy, Fe and Zn in both seasons and Mn in 2016, while H3 had the highest Mn value in 2015. AN was treatment with the highest average Pphy value, while OF and BF slightly reduced Pphy in both seasons. BF achieved higher average Zn value, while in control the highest Fe and Mn values were obtained.

PCA declared that PC1 and PC2 participated by 57.71% and 26.72%, in total variability. Results in Figure 1 reveal C and BF as the treatments with expressed the highest impact on variability of Zn and Fe, and in slight extent of Mn variability. This underlines importance of soil microorganisms in absorption and increased accumulation of Fe, Mn, Zn and Cu in plant tissues [2]. It is also important to mention that factors that contribute to the increased Fe and Zn concentrations are not linked to Pphy concentration, providing better Fe and Zn absorption from digestive organs [3; 4].

CONCLUSION

It was established that Fe, Zn and Mn concentrations in maize grain highly depends on meteorological factors, while Pphy has low variability. H1 was characterised with the highest Fe and Zn values, while H3 had the highest Mn value. Fertilization is measure that could improve Fe, Zn and Mn accumulation in maize grain, particularly application of biofertilizer or cropping without fertilization, thus underlining importance of low-input agriculture, such organic agriculture is.

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