ZINC - MICROELEMENT OF REFERENCE IN APPLE NUTRITION

Diana Elena BOLOHAN[1], Mariana VOLF [1]

e-mail: bolohandiana@yahoo.com

Abstract

This paper aims to present the risk of being exposed apple trees to zinc deficiency, within an bifactorial experience with fertilizers. Mobile Zn content in soil, on one hand and total zinc content in plant material (leaves) on the other hand, as mobile phosphates content in soil, represents agrochemical indices for assessing the probability of zinc deficiency. These indices determined during two years of experimentation, can be quantified in two synthetic indicators IRPM - mobile phosphates reaction index in soil, used for chernozems, that express and explain the influence of pH and available phosphorus content (P-AL ppm) on Zn mobility in soil and its availability to plants; and ICZn - zinc deficiency index, which takes into consideration the value of mobile Zn content in soil, being more significant in order to predict the probability of zinc deficiency appearance. Folowing the fertilization of experimental variants, we analyzed the data obtained during two consecutive years of experience, and noticed that available phosphorus content in soil increased gradually, while mobile Zn, although increasing quantity, it lies within suboptimal limits. Together these values and soil pH, which has the tendency to rise up to 8.00, the two indices calculated ICZn and IRPM, clearly indicates that the probability of deficiency in zinc appearance is medium to large, ICZn take values between 1.39 and 3.13, while IRPM take values between 0.117 and 0.232.

Key words: apple trees, fertilization, zinc, phosphorus,

Zinc is an important microelement in mineral nutrition of apple trees, contributing to a normal growth and development. It plays an important role in fecundation, impregnating resistance to pathogens attack and decisively influencing the quality of the apple crop. Impact of zinc presence in the plant tissues can be translated as its implication in biochemical process through its role in enzyme activity, in photosynthesis, protein synthesis and not least by ensuring an adequate stability and permeability of cellular membranes.

Regarding apple culture, there occurs both the risk of deficiency and toxicity phenomena. It is known that apple trees are sensitive to zinc deficiency and less to the toxic effect that occurs following the uncontrolled treatment for plant protection with products based on Zn, in disease control. There are a couple of factors that influence appearance of zinc deficiency in plants and must be taken into account: plants susceptibility, soil conditions, climatic conditions and also agricultural applied agrotechnics (Budoi, 2000).

Soil, by its physical and chemical attributes, is the most representative factor in the likelihood phenomenon of Zn deficiency and may exercise this attribute, with a value exceeding seven pH_{H2O} by low content of mobile Zn, the presence of carbonates, available phosphorus content exceeding 50 ppm, a low content of humus, surface erosion, compaction and also through degradation.

This is why the central objective of research in this paper is forecasting the occurrence of zinc deficiency phenomenon, reflected by the determination and calculation of simple and synthetic indicators that aim the insurance status of available phosphorus and mobile zinc in soil. This makes possible to limit this phenomenon through agricultural practice - appropriate fertilization.

The obtained results lead to the conclusion that forecasted zinc nutritional disorders (deficiency) for apple trees is a prerequisite in the context of phosphate fertilization, along with adjusting the ionic composition of the soil and by maintaining the soil pH in acid to neutral field (Huang et al., 2000).

MATERIAL AND METHOD

Researches were carried out in „Vasile Adamachi” Farm, Iassy county, in 2010. This study was conducted over one crop Idared variety apple trees, in a 4x4m spacing.

Fertilizing treatments were randomised within one block; groups of three trees; in three replications. In the experience were studied 9 variants of fertilization with mineral and foliar fertilizers, including the blank:

[1]University of Agricultural Sciences and Veterinary Medicine Iasi

V1 - control;
V2 -mineral fertilization - N60:P60:K60;
V3 -mineral fertilization - N90:P90:K90;
V4 -foliar fertilization - Pentakeep - G;
V5 -foliar fertilization - Cropmax;
V6 -mineral fertilization N60P60K60+Pentakeep-G;
V7 -mineral fertilization N90P90K90+Pentakeep-G;
V8 - mineral fertilization N60P60K60+Cropmax;
V9 -mineral fertilization N90P90K90+Cropmax;

NPK15.15.15 was applied 1/3 in autumn and 2/3 in early spring. Foliar fertilizers (Cropmax and Pentakep-G) were applied three times, starting when the fruit was 5 mm in diameter, and every two weeks after. Soil pH was determined in water through potentiometric method.

Soil and leaves samples were analysed for:

- P-AL = available phosphorus content in soil, extracted by the Egner-Riehm-Domingo method, by spectrophotometry;
- Pt% - total phosphorus content in leaves , by spectrophotometry;
- available Zn content in soil, extracted in EDTA 0,01 N solution, determined by atomic absorbtion;
- total Zn content in leaves by atomic absorbtion.

RESULTS AND DISCUSSIONS

Analyzing obtained data *(table 1)* there is an increase of mobile phosphorus content in soil directly proportional to gradually increased doses of fertilizers administered on variants, but also there is an increase from one year to another. In 2010, mobile phosphorus content in soil recorded 48 ppm for unfertilized variant, up to 66 ppm for N90P90K90+Cropmax variant, that fits soil to a low state of insurance (36.1 to 72 ppm).

Table 1

Phosphorus content in plant and soil, over 2 years of fertilization

Fertilization variants	2010		2011	
	Pt (%) in plant	P – AL(ppm) in soil	Pt (%) in plant	P – AL(ppm) in soil
Control (unfertilised)	0.29	48	0.32	70
N60P60K60	0.33	56	0.32	81
N90P90K90	0.33	63	0.33	82
Pentakeep - G	0.28	43	0.31	71
Cropmax	0.24	46	0.32	71
N60P60K60 + Pentakeep-G	0.30	48	0.32	82
N90P90K90 + Pentakeep-G	0.30	65	0.35	96
N60P60K60 + Cropmax	0.30	64	0.32	85
N90P90K90 + Cropmax	0.31	66	0.35	87

In 2011 there was an improvement of phosphates content in soil, phosphorus content recorded values of 70 ppm in unfertilised variant, up to 96 ppm in N90P90K90 + Pentakeep-G variant of fertilization, insurance state of soil was medium (72.1 to 108 ppm).

In table 2 are presented values of mobile Zn content in soil and plant material. Mobile Zn content in soil in 2010 and 2011 ranks at optimum for most variants of fertilization (> 1.4 ppm, Vintila, 1984), while the Zn content of plant material are below optimal (20-200 ppm Zn, Budoi, 2000) for all fertilization variants.

Table 2

Zinc content in plant and soil, over 2 years of fertilization

Fertilization variants	2010		2011	
	Zn (ppm) in plant	Mobile Zn (ppm) in soil	Zn (ppm) in plant	Mobile Zn (ppm) in soil
Blank	10.92	2.50	13.06	2.3
N60P60K60	10.89	2.11	14.40	2.01
N90P90K90	10.91	2.46	13.39	2.3
Pentakeep - G	11.66	2.50	14.27	2.7
Cropmax	12.26	2.11	15.01	2.3
N60P60K60 + Pentakeep-G	10.39	2.46	15.16	2.4
N90P90K90 + Pentakeep-G	10.92	2.50	15.09	2.6
N60P60K60 + Cropmax	9.79	2.11	12.97	2.2
N90P90K90 + Cropmax	10.90	2.46	18.99	2.3

The literature cites the occurrence of critical levels of Zn deficiency hidden value 17.00 ppm for tree species. We observe that zinc content values in leaves fall below this threshold, for all variants of fertilization, that indicates the risk limit for visible manifestation of deficiencies (12-15 ppm Zn total)

The values presented in table 3 express the probability of zinc deficiency, for the apple trees, over two years of experience, two synthetic indicators quantified by reference, ICZN- zinc deficiency index and IRPM – mobile phosphates reaction index.

For 2010 ICZn values are between 1.78 and 3.13, values over the the threshold of 1.70. In 2011, in most variants, ICZn values falls below this threshold, except Pentakeep – G fertilization variant, which shows that the probability of zinc deficiency occurence is appreciable in the first year and in the second year this issue is much more accentuated.

Table 3

ICZn and IRPM absolute values, over 2 years of fertilization

Fertilization variants	2010		2011	
	ICZn	IRPM	ICZn	IRPM
Blank	2.81	0.208	1.77	0.142
N60P60K60	2.03	0.178	1.34	0.123
N90P90K90	2.10	0.156	1.51	0.121
Pentakeep - G	3.13	0.233	2.05	0.140
Cropmax	2.47	0.217	1.74	0.140
N60P60K60 + Pentakeep-G	2.76	0.208	1.58	0.121
N90P90K90 + Pentakeep-G	2.07	0.153	1.46	0.104
N60P60K60 + Cropmax	1.78	0.156	1.39	0.117
N90P90K90 + Cropmax	2.01	0.151	1.42	0.114

For interpretation of zinc deficiency occurence by IRPM, we remark that values are below 0.288 for all variants of fertilization, for both years 2010 and 2011, which shows high probability of zinc deficiency expression (Borlan, 1994).

Figure 1, 2, 3 and 4 express the values of all indicators, simple and synthetic, involved in assessing and predicting the occurrence of zinc deficiency, namely P-AL (ppm), mobile Zn (ppm), IRPM and ICZn.

Interpreted by ICZn values, Zn deficiency in the apple trees is moderate in 2010 and high in 2011, increase proportional with increasing phosphate in soil for 2011 compared to 2010, for all variants of fertilization.

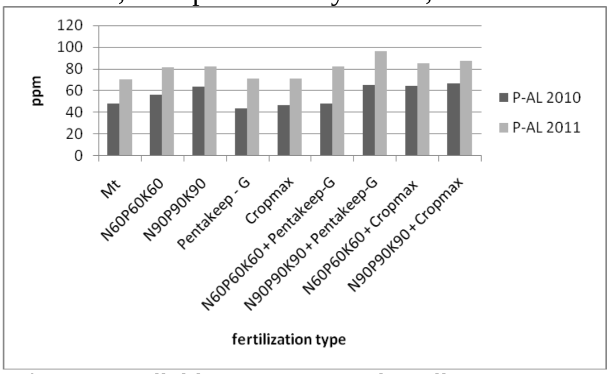

Figure 1 **Available P-AL content in soil over 2 years**

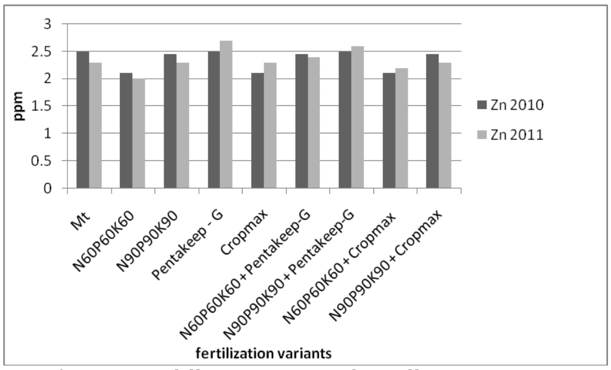

Figure 2 **Mobile Zn content in soil over 2 years**

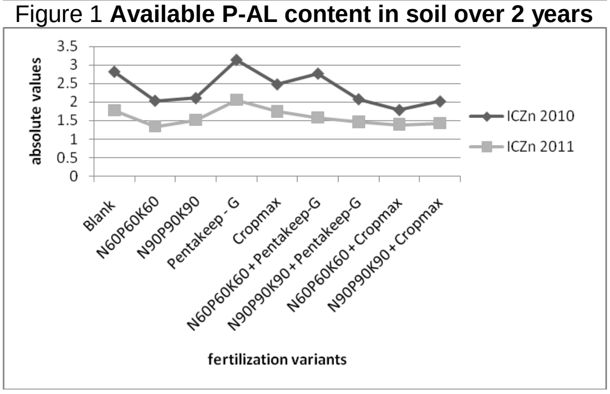

Figure 3 **ICZn absolute values over 2 years**

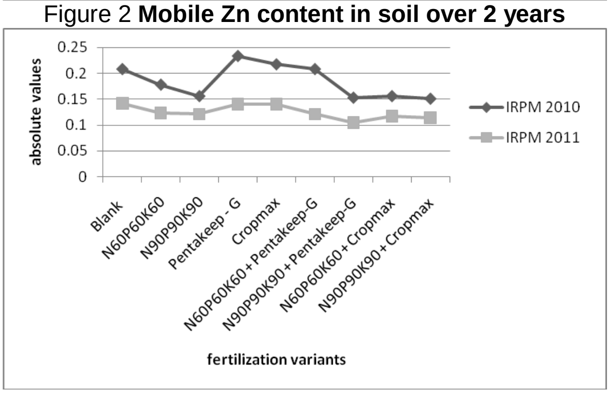

Figure 4 **IRPM absolute values over 2 years**

The tendency of zinc immobilization in soil occurs due to the pH of alkaline soil and alkaline carbonates presence at 60 cm depth.

Even if mobile Zn content in soil is normal, values of plant material analysis indicate a weak state of suply, which explains a failure in its absorption. This indicator is used when there are data from foliar diagnostic which can express much better zinc deficiency risk, even if symptoms have not occurred yet

Mobile phosphates reaction index (IRPM) is more general and takes into account only the level of phosphate content in soil and the pH. From this point of view, IRPM indicate a high probability of occurrence of zinc deficiency for both experimental years, drawing attention especially the upward trend of mobile phosphorus content in soil. Although P-AL values in the soil is below optimum, IRPM is most likely used for soils with pH that reach values of 8.00.

CONCLUSIONS

Zinc, along with other microelements are important in plant mineral nutrition, especially for those with medium and high susceptibility to deficiency, that disturb a series of biochemical processes and decisively influence plant growth and development.

Apple tree is one of the susceptible species to the occurrence of zinc deficiency, according to the undertaken study where ICZn and IRPM determined values were below the limit of 1.70, respectively as 0.218.

The increase of soil phosphate content and alkaline pH has a negative impact on the zinc mobility and accessibility, inducing zinc deficiency initially hidden, detected by foliar analysis, and then visible deficiency (developing symptoms), more difficult to control and correct.

In variants fertilized exclusively with foliar fertilizers, Pentakeep - G and Cropmax, with zinc besides other nutritive elements, are observed IRPM and ICZn values significantly higher, which explains extraroot nutrition as preventing measure of zinc deficiency.

REFERENCES

Budoi, Gh., 2000 – *Solul si planta*, Ed.Didactica si Pedagogica R.A., Bucuresti

Borlan, Z. et al., 1994 – *Fertilitatea si fertilizarea solurilor.* (Compediu de agrochimie), Ed.Ceres, Bucuresti

Huang Chunyuan et al., 2000 - Zinc *deficiency up-regulates expression of high-affinity phosphate transporter genes in both phosphate- sufficient and -deficient barley roots, Plant Physiology,* Vol. 124, pp. 415–422

Vintila, I. et al., 1984 – *Situatia agrochimica a solurilor din Romania-prezent si viitor,* Ed.Ceres, Bucuresti