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FOLIAR FERTILIZATION OF CULTIVATED PLANTS IMPROVE THEIR RESISTANCE TO ENVIRONMENTAL STRESS AND PATHOGENS - minireview

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Abstract. Foliar treatment of plants is an up to date methods for fertilization. The biostimulation of plant metabolism was demonstrated. This review reveal the main aspects of the fertilization by foliar application. We show the importance of this method for plant protection against diseases and environmental stress.

Key words: Foliar fertilizers, biostimulation, plant protection

INTRODUCTION

The foliar fertilization was first conceived in 1844. Later, the production of foliar fertilizers were developed following studies of foliar absorption performed in State University of Michigan in 1953 (Bukovak & Wittwer, 1957) demonstrated by radioisotopes traced minerals, and autoradiography, that even the bark of the trees are able to absorb the nutrients. The foliar application has great results, but it must be sufficient area of foliar surface in order to be effective and be preceded by test in order to see plant deficits in elements (Fageria et al., 2009), in the same time being more economic in some conditions and completing the soil fertilization. In the same time was demonstrated the absorption of different pollutant in the same manner (Hosker & Lindberg, 1982). The foliar biofertilizer will not replace the soil application. Depending of the elements used in foliar application, different results were obtained. The foliar absorption of Zn was studied by Synchrotron based X ray fluorescence microscopy (Du et al., 2015) at tomato and citrus leaves which revealed different accumulation and absorption to the species observed and the Zn particle tend to bind and limits the distribution in plants the concentrations in subjacent tissues was 600 fold in tomato leaves and only 5 fold in citrus leaves compared with surface. The species of plant has an importance in this absorption. Anyway is a real challenge to understand the uptake and translocation of the nutrients solutions (Fernandez & Brown, 2013).

The biostimulatory effect is discussed in the case of foliar application at soybean culture together with different bio regulators (Piccinin et al., 2013), which confers to the culture a better resistance to diseases and environmental factors. The tomatoes grown in high NaCl content, treatment with P and K, can increase water use, increase the dry matter in plants (Kaya et al., 2001). The addition of foliar spray fertilization with silicic acid 4 ml/l reduce the necessary pesticide treatment with half in rice cultures (Prakash et al, 2011). Different foliar fertilization, depending of its doses, can inhibit development of phytopathogens as *Stemphyllium vesicarius* which produces blight of onion (Mishra & Singh, 2017).

DISCUSSIONS

Silica is not essential for plant growth, but it accumulate in conditions of abiotic and biotic stress (Ma, 2004). The foliar fertilization play a role top give some necessary elements and microelements for plant growth, with good effects on yield and crop production. For example, the differents application of silicon was tested to rice culture, and foliar application was most effective in production growth with application of 20-80 mg Si/L (Agostinho et al, 2017). Silicic acid was tested by foliar application to soybean, bean and peanuts cultures (Crusciol et al., 2013), and potato (Crusciol et al., 2009), increase resitance to drough stress in potato plants, dn growth of production in soybeans and number of pods, at 2 l/ha applied as foliar formulation. The application of silicid acidis regfarded as biostimulant in low doses (Laane, 2016). Liang et al. (2005) found that foliar aplication of Si can enhance resistance to *Podosphaera xhantii* attack only at the level of physical barrier on leaves surface deposition.

Copper is a well known element used in different formulation against phytopathogens. Using inorganic Cu nanoparticle is the main interest for microelement fertilization, but as secondary purpose is to use it as defence against phytopathogens (Antonoglou et al. 2018). CuZn bimetallic nanoparticles which acts as antifungals with reduced phytotoxicity, and having even best efficiency as monometallic Cu nanoparticles. The application of Cu and B foliar fertilization to rice, has an effect of reduction of the pathogens attack and increase of the grain yield (Liew et al., 2012).

The foliar application of Zn to wheat in the late phase of development of the grain increased the Zn content from 11 mg /kg to double (Cakmak et al., 2010). Zn can improve enzymes activity and as consequence production of rice (Mathpal et al., 2015). The Zn application alone or together with NPK treatment improve Zn content and increase content in wheat grains and assure a dietary intake (Wang et al., 2017) in consumers. The macronutrients can assure a superior, better uptake of Zn in sunflower too (Tian et al., 2015). Zn is an essential oligoelement necessary for human development and this can be taken from food in Asia in special from rice, that's why is important to act for better rice, by biofortification and genetics (Swami et al, 2016). Regarding *Pisum sativum*, concentration of more than 60 mg/kg of Zn were found in beans after foliar Zn fertilizers applications (Poblaciones et al., 2016).

Application of selenium improve plant fit to resist environmental factors and increase yield to peanut cultures, the best results being when applied as foliar spray at 40 days after flowering (Irmak, 2017). Application of foliar treatment in low doses can correct the P uptake and efficient use of it in wheat (Mosali et al., 2006).

Applications of Co and Mo by seed and foliar application, together with seed inoculation with *Azospirillum brasilense* can increase production and N intake in soya bean culture (Galindo et al, 2017), improving grain yeld. The foliar fertilization is limited by the capacity of the surface foliar area, but its compensate the insuficient uptake of nutrients by the roots at maize plants (Ling & Silberbush, 2002).

Many micronutrients applied in foliar fertilisation can affect the incidence and severity of diseases. The N macronutrient supply increase the severity of infection, but K decrease the plant susceptbility, Mn also decrease attack by stimulating lignin biosynthesis, B decrease severity of diseases, and Zn and P gived variable results (Dordas, 2008). Some of the foliar fertilizers in some concentraions can increase efect others can decrease antagonisic effects of *Trichoderna* strains (Dłużniewska, 2008). Application of urea like foliar fertilizer can decrease N deficiency of grapevine plants, helping to improve wine quality (Perez- Alvarez et al., 2017). At soya bean cultures from Serbia were applied foliar fertilizers as Ferticare and Wuxal Super together with urea soil application. The foliar fertilization reduces negative impact of low rainfall (Mandic et al., 2015).

Future developments. Nanofoliar fertilizer application can be a solution of sustainable development, and being the basis for new fertilizer products (Li et al., 2016). The role played by foliar application in nanodrops of micronutrients and pesticides is revealed by Alsbaal and El-Ramady (2017) which also discussed the role of foliar fertilization in bio-fortification and protection of cultures. Nanotechnology will shape plant cultivation and plant protection in this new century, some gamma Fe2O 3 nanoparticle used by foliar application (Hu et al., 2017) which can reduce nutrient loss in plants, and improve wax synthesis in *Citrus maxima* leaves. Application of nanoparticle of chitosan and Zn can assure to the maize cultivated on Zn deficient soil the necessary Zn intake (Deshpande et al., 2017). The environmental and health risk of application of pesticides and of fertilizers, at nano scale is low, in the same time particle uptake by foliar delivery is more effective. All this process was observed and quantified by Inductively Coupled Plasma Mss Spectroscopy in an experiment in water melon with gold nanoparticles aerosols (Raliya et al., 2016). The particles translocation use stomata and the transportation are done by phloem system.

CONCLUSIONS

The need for supplementary fertilization is fulfilled by foliar fertilization generally speaking with micro or oligoelements which assure a better metabolism and a better resistance of the cultivated plant to drought and other environmental stress, and in the same time resistance to main phytopathogens. New researches were made in order to provide nutrients in nanodrops and nano formulation in order to avoid phyto and environmental toxicity and assure a high efficiency.

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