AVOIDING CONFUSIONS BETWEEN THE VISUAL SYMPTOMS OF THE PLANT NUTRIENT DISORDERS AND BETWEEN THESE AND THOSE DETERMINED BY OTHER CAUSES: *a) MACRONUTRIENTS*

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Abstract. *The paper brings new and important contributions regarding the diagnosis of the macronutrients nutritional disorders of plants by visual symptoms. The specific aspects of the micronutrients are presented in a paper complementary to this. In putting the diagnostic, confusions between different nutrients can appear, as well as between nutritional symptoms and those produced by diseases, pests, water bogging, increased soil compaction, high weed density, light insufficiency, physiological leaves ageing, pollution etc. The paper emphasis aspects that allow discriminate between the mentioned causes and put of a right diagnostic. In the limited area of the paper a series of original images is also presented.*

INTRODUCTION

The diagnosis of the nutrient disorders by visual symptoms is the first method available for the cultivator, the most rapid, the cheapest and the one which allows taking immediate correction measures when the diagnostic is clear. Only when there are doubts, plant and even soil analyses have to be made. Important contributions to the visual diagnosis brought Bergman (1992), Borlan et al (1992), Budoi (2000, 2001), Marschner (1993), Mengel and Kirkby (1987), Wallace (1961), et al. Some of them (Bergman, 1992, Borlan et al, 1992, Budoi, 2000) presented disorder identification keys. These two complementary papers bring new contributions, which represent basis for the improvement of such keys.

MATERIAL AND METHOD

Researches have been carried out by studying a high number of plant species: field crops, fruit trees and shrubs, grapevine, vegetables, flowers and ornamental wood species. By comparison with normal healthy plants, the observations have been made on plants which showed visual symptoms of nutritional disorders and on plants with visual symptoms determined by other factors. Numerous reference papers in the field of plant protection have been also consulted.

RESULTS AND DISCUSSIONS

The way in which nutritional disorders manifest visually and extend on plants depends on the specific function of each nutrient, and in the case of deficiency, it also depends also on its mobility within the plant and on the possibility of its retranslocation from old tissues or organs into the younger ones,

poorer in that nutrient. The disorders can manifest by visual symptoms on different plant's organs, the most taken into consideration being the leaf. In the case of *nutrients with high mobility* within the plant – such as the first four essential macronutrients: *N, P, K and Mg*, which make the object of agrochemical interventions – nutrients that can be retranslocated to the growing points, the *visual symptoms of the deficiencies appear first on the oldest leaves* from the base of plant or yearly shoots, or from the exterior of leaf rosette (e.g. sugar beet, cabbage) and extend from the base to the top, or from the exterior to the interior of the rosette, respectively, in the case of deficiency's persistence. To the *nutrients*

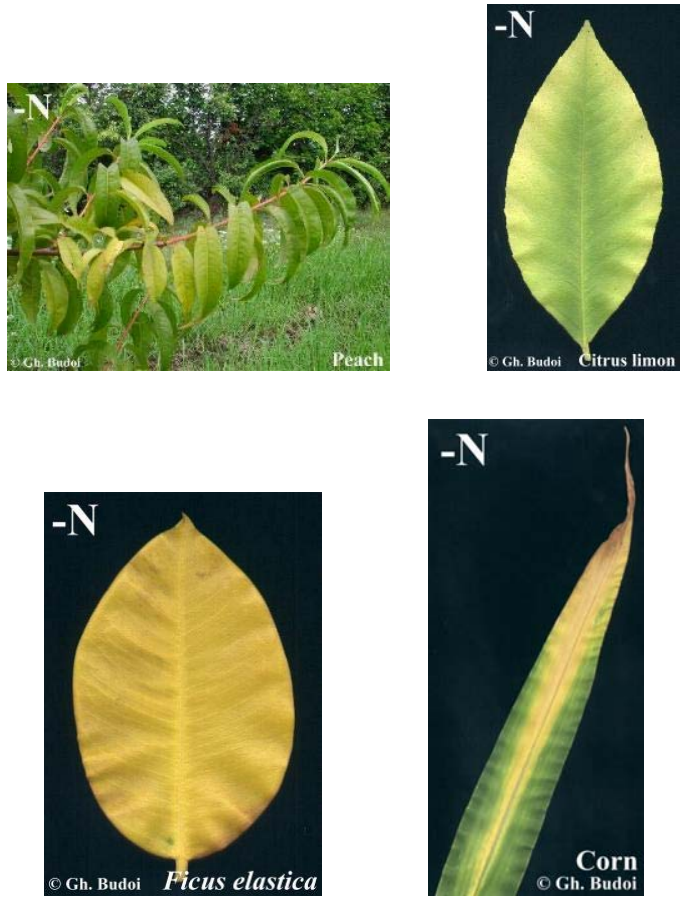

Fig. 1. Visual symptoms of N deficiency: appear first on basal leaves and extend towards those from tip (see peach); chlorisis beginning from the top and borders of lamina *(Citrus sinensis)* (the most general case); relative uniform chlorisis on all lamina *(Ficus elastica)*; chlorisis in V shape with the tip on median vein (particular case, e.g. corn) (original images, copyright Gh. Budoi)

with very reduced mobility, considered practically *immobile* (Ca, B, Fe, Mn), the *visual deficiencies appear* first on *younger leaves* and on *growing points*, usually being localized, and gradually extend toward the basal old leaves.

N deficiency. The visual symptoms appear *first on old leaves from the base* of plant or yearly shoots (see fig. 1, peach) and extend toward young leaves from top. The lamina, including the veins, chloroses, turns yellow, usually starting from the top and edges, to most species it necrosis and finally scorches and dies, generally turning yellow-brownish up to brown. There are also species in which the leaf yellowing takes place almost uniformly on the entire leaf surface (fig. 1: *Ficus elastica*). The species with thick or waxed leaves, usually do not get to necrosis, but only leaves' yellowing occurs *(Ficus elastica)*, sometimes these getting subsequently red tints on borders (some *Crassulaceae*) or even on the entire leaves (some peach varieties) (fig. 1), afterwards they fall prematurely. In fruit trees, for example, the advancement of leaf chlorisis from the borders toward the center is less evident, while it is clearer in herbaceous species, especially to those with wide leaves. In some species, such as corn, the chlorisis advances on leaf in a V letter shape with the tip on median vein (fig. 1).

The N deficiency can be confused with other causes. In order to avoid the confusion with K deficiency, see the K deficiency below. Details regarding the avoiding criteria of confusions with *S deficiency* and with symptoms produced by *watter bogging,* increased *soil compactation, high weed density*, *physiological* leaves *ageing*, *light insufficiency*, *diseases*, especially virosis, have been presented in another paper (Budoi, 2001).

Fig. 2. **P deficiency in peach –** ***Prunus persica*** (original image, copyright Gh. Budoi)

P deficiency. The visual symptoms appear *first on the leaves from the base* of plant or yearly shoots and spread towards those from tip. The leaves get a dark color, have "dull green tints", and then, in many species, get "dull purple tints" or "dull purple-violaceous tints" (cabbage, carot, corn, raddish, tomatoes, sweede, wheat), "dull bronze tints" (apple, sugar beet, fodder beet), reddish tints (rape, envolved from purple tints) or purple-reddish tints (marrowstem kale), more intense on petiol, on veines (on dorsal side of leaf) and on leaf's borders (fig. 2). Some species (celery, clover, flax) have "dull bluish green tints". It is to be mentioned the fact that in fruit trees and shrubs the most frequent appear "dull green tints", which are more dificult to be observed, the violaceous tints appearing harder than in herbaceous species, when the deficiency is already severe, drasticaly afecting the yield. However, they are easier to be observed in apple tree, peach tree and blueberry than in other species.

The violaceous and reddish-violaceous tints determined by P deficiency must not be confused with the violaceous tints produced by K deficiency (fig. 3),

or with the reddish-violaceous tints determined by Mg deficiency, to some grapevine varieties (see the K and Mg deficiency underneath). For other aspects, see Budoi, 2001.

K deficiency. Like in N and P, the visual symptoms appear *first on the leaves form the base* of plant or yearly shoots and progress towards those from tip. Generally, the marginal chlorisis of the lamina are rapidely followed by brown (fig. 3, *Calathea*), greish-brown, reddish-brown up to dark brown necrosis (scorches) which progress towards the median vein. Finally, the leaves drye and die.

Fig. 3. K deficiency in *Calathea longifolia* (marginal necrosis, general case)**, and in grapevine, "Black Kişmiş" variety** (particular case: violaceous tints followed by brown necrosis) (original images, copyright Gh. Budoi)

Confusions with symptoms of other nutrients deficiencies. The difference from the necrosis determined by *N deficiency* is that in K the passing between the necrosed zones and the green one is much clearer, while in N it is more gradual, more difuse. In tomatoes, the K deficiency resembles somewhat to *Mg deficiency*. The diference is that to K chlorosis and necrosis appear beginning with the border of the lamina, while to Mg the chlorisis appear usualy beginning from the center of the lamina and its base, the borders remaining green for a long time. A particular case concerning the way of visual manifestation of K deficiency is that from some red grapevine cultivars, such as "Black Kişmiş" (fig. 3) and "Müller Thurgau", in which, beginning with the edges of the lamina violaceous tints appear first, the photosynthesis being evidently affected, followed later by brown scorches of the leaves starting also from edges. The passing between the violaceous area and the green one is also clear. These violaceous tints must not be confused with those given by *P deficiency* to most plant species, in which the passage between the violaceous areas and the green ones is more gradual, more difuse (fig. 2).

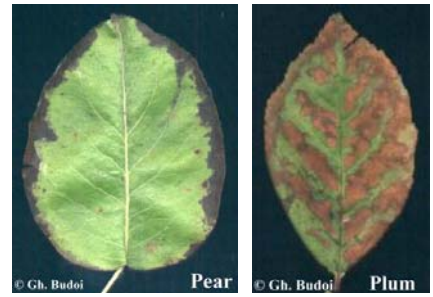

Fig. 4. **Necrosis determined by pesticides: similar to K deficiency in peach and to Mg in plum tree** (original images, copyright Gh. Budoi)

Confusions with symptoms of some pesticide phytotoxicity. In the case of the application of some unrecommended pesticides for a given crop or, more frequently, of the application of too higher concentrations or too higher volume of solution, especially in the turning zones from the ends of rows, there appear phytotoxicities manifested by marginal necrosis similar to K deficiency (fig. 4, pear tree), or interveinal necrosis similar to Mg deficiency (fig. 4, plum tree).

But, in the case of phytotoxicities, the necrosis are much faster than in the case of nutrient deficiencies and they are not localized on the plant, they affect all the leaves on which the pesticide was applied, and in the case of systemic pesticides, they affect all the leaves of the plant.

Mg deficiency. Like in N, P and K, the visual symptoms appear *first on the leaves from the base* of the plant or yearly shoots and progress towards those from tip. From all nutrients, to Mg the visual symptoms of the leaves vary the most according to plant species. To most *Dicotiledonatae,* on leaves appear marginal chlorisis, followed or not by tissues' necrosis (most frequently, yes), which progress between the main veins towards the median vein; generally, *the median vein, the main veins and a bend along them remain green* long time from the chlorosis' appearance (fig. 5), this band being narrower towards the end of the vein and more and more larger towards the base of the vein. In tomatoes, a green area at the lamina's edge can persist for a long time (fig. 5). In some species (cotton, cucumber, potato, sweet cherry tree), the chlorisis and necrosis begin from the middle of the lamina and progress towards the borders. For other details,

Fig. 5. **Visual symptoms of Mg deficiency on basal leaves of: lemon tree – *Citrus limon,* tomato – leaflet, apple tree –"Golden delicious" variety** (original images, copyright Gh. Budoi)

see Budoi, 2000, 2001.

It is interesting to be noted the fact that even in the framework of the same species there are certain high differences concerning the visual appearance and manifestation of the Mg deficiency, which can mislead. Thus, in apple tree – "Golden delicious" variety (fig. 5), the interveinal chlorisis appear from the

lamina's edges and progress much towards the median vein without being followed by necrosis, or they fall without getting to necrosis. On the contrary, to other varieties, such as "Alkmene", reddish-brown necrosis appear directly in the green tissus, without previous chlorisis and with clear passing from the necrosed area to the green one; to such varieties, the necrosis appear and are usualy most frequent at half distance between the lamina's edges and the median vein or nearer to the median vein; sometimes the necrosis can be asimetrical, affecting either only a half of the lamina, or more a half.

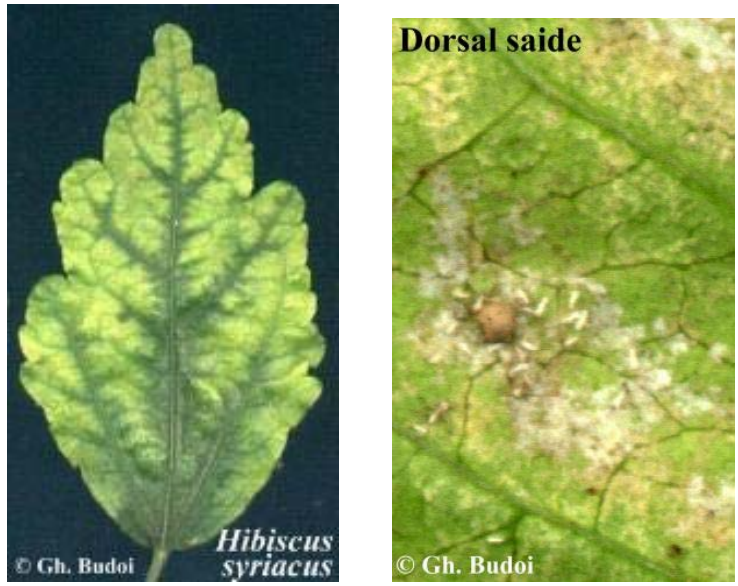

Fig. 6. Symptoms of the attack of *Trialeurodes vaporarium* in *Hibiscus syriacus* similar to Mg deficiency (left); right – detail of dorsal face, with very dense exuviae in chlorosed area between main veins (original images, copyright Gh. Budoi)

Confusions with pests attack. To some species, like *Hibiscus syriacus* (fig. 6), the visual symptoms on the ventral face of the leaf determined by the attack of leaf looses, such as *Trialeurodes vaporarium* – white midge, are very much alike those of Mg deficiency, the area between the main veins being yellow, and the veins and a band along them being still green. To the attack of sucking insects, the nerves remain green for a longer period of time because the cell's walls are more lignified, more difficult to be penetrated by the sucking insects as compared to

those of the cells of the tissue among the veins and from the lamina's edges. These two causes can be differentiated as follows: in the case of looses, on the dorsal face can be seen either the insects, or their exuviae, very dense exactly in the yellow area of the lamina (fig. 6), discoloring caused by the sucking of the cell's sap and disturbance of the chlorophyll's synthesis and activity; in the case of the nutrient deficiency, the symptoms are more intense on basal leaves, while to the leaf looses they are more spread on the younger leaves from the upper third of the yearly shoots; the looses' attack determines distortions of the leaf's lamina, especially gofferings, wavings, which does not determine the Mg deficiency. The problem becomes more complicated when there are both Mg deficiency and looses attack, because then the looses install easier on the older leaves, debilitated by deficiency. Then, we have to do leaf analysis.

Confusions with diseases. In the *mosaic virus* of the *Abutilon pictum "Thompsonii"*, the leaves are mottled by the virus. The chlorisis in points and spots affect more the interveinal area, but unlike the Mg deficiency the virose also affects the main nerves here and there, and in the virose the interveinal chlorisis are discontinuous, while in Mg they are continuous. For many other deseases, see Budoi, 2001.

CONCLUSIONS

The diagnosis of the nutrient disorders by visual symptoms is the first method available for the cultivator, the most rapid, the cheapest and which allows taking immediately correction measures.

This method is liable of confusions between nutrients and between nutrients and other causes: diseases, pests, water bogging, increased soil compaction, high weed density, light insufficiency, physiological leaves ageing, pollution etc. There are many possibilities to avoid confusions and so this method be a valuable tool in managing crops technologies. This paper presents such useful criteria for macronutrients.

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