THE POSSIBILITY OF USING FLORAL ANALYSIS TO DIAGNOSE THE NUTRITIONAL STATUS OF PEAR TREES

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Abstract

Floral analysis, due to the time at which it is performed, gives appreciably earlier results than leaf analysis. This paper will explore the possibility of using it to predict Fe and Mn content of leaves taken 120 days after full bloom. Given the increase in the degree of variation of Fe content in flowers compared to that of leaves, this could be a good way of predicting iron chlorosis.

1. Introduction

The diagnosis of nutrients present in crops via the interpretation of floral and foliar analysis constitutes, at present, the best and most commonly used way of evaluating the nutritional status of plants. This proves to be of great importance for crop yield.

This practice, which has been widely tested, establishes that by evaluating the nutrients present in leaves we can establish the nutritional status of the plant. The proven relationship between the quantity of a plant's nutrients and yield enables us to use leaf analysis to improve nutrition and yield, by means of appropriate growing techniques. An important improvement in this area was the application of DRIS methodology (Beaufils, 1973; Davee et al., 1986; Goh and Malakouti, 1992; Parent and Granger, 1989; Sumner, 1986; Szucs et al, 1990) and later on the DOP methodology (Montañés et al, 1993).

The practical application of this technique has several limitations. One of the conditioning factors is the time when its application is possible. Bergmann (1992) points out that a possible improvement in yield and in the quality and quantity of crops by supplementing the fertilization during the growth cycle, where necessary, will only be effective if applied in time.

At present, the standard time for leaf sampling on fruit trees is 120 days after full bloom, midsummer in the Northern Hemisphere. Past research (Sanz et al, 1992 a) has managed to bring this time forward to 60 days after full bloom in peach trees or even to extend it to include the whole vegetative cycle (Sanz et al, 1993 a). Other writers have found it possible to bring diagnosis forward for trees such as peach (Leece et al, 1974), apricot (Leece et al, 1975a), plum (Leece, 1975b), and cherry (Leece, 1975c), by establishing mathematical formulae, which are then applied in order to

transform reference values into foliar diagnosis. As a solution to this same problem, other studies recommend the use of the DRIS system, which enables leaf analysis to be applied throughout the vegetative cycle. Nevertheless, this system has yet to be fully approved.

Floral analysis offers the possibility of determining the nutritional status of crops and correcting deficiencies, if necessary, at an earlier stage. In a study on peach trees (Sanz et al, 1992 a), carried out parallel to this one, a close correlation was found to exist between the nutrient content (N, P, K, Ca, Mg, Fe, Mn, Cu and Zn) of leaves taken 120 days after full bloom and the content of these same nutrients found in flowers. The application of floral analysis on pear trees and the subsequent diagnosis would mean that nutritional problems could be spotted at an earlier stage. It has already been established that there is a direct relationship between the mineral content of leaves and yield (Sanz et al, 1993 a). We will therefore try to find a relationship between the nutrient content of leaves and that of flowers, and indirectly relate the latter to harvest yield.

2. Materials and methods

The study was carried out on 100 pear tree (*Pyrus communis*. L.) orchards, located in the main production areas of this fruit tree in the Mid Ebro Basin, N E Spain. The only criteria used when choosing the orchards was that they should be in full bearing. Growing techniques, variety, soil type, etc. were not taken into account.

Nevertheless all the areas used for growing fruit trees in the studied region (Montañés et al, 1975) have as common characteristics; fertile soil with high pH and high carbonate content and high active lime.

When the orchards were in full bloom, five trees were chosen from each and marked to ensure that successive samples would be taken from the same tree. Open flowers, including the stem, were taken from the central part of bearing branches, at full bloom, irrespective of the age of branches.

Sixty days after full bloom, ie, the second fortnight in May, leaf samples from the central third of new shoots were taken from the trees which had previously given the flower samples. This operation was then repeated during the second fortnight in July, 120 days after full bloom. Leaf samples were taken from the same trees and in the same way.

Both flowers and leaves were analyzed using methods proposed by the Inter-Institutes Committee (1969) and Pinta (1973) and results were expressed as percentage of dry matter for macroelements (N, P, K, Ca and Mg) and as ppm of dry matter for microelements (Fe, Mn, Cu and Zn).

Statistical calculations were carried out using the SPSS computer program.

3. Results and discussion

Table 1 shows some of the features obtained from the analysis of nutrients found in flowers from the pear trees which were used in this study.

Table 2 shows the same results obtained from the analysis of nutrients in pear tree leaves taken 120 days after full bloom.

If we compare the nutrients present in flowers with those present in leaves, (see tables 1 and 2) the following observations can be made:

N, P, and K are present in greater quantities in the flower.

Ca and Mg are present in greater quantities in the leaf.

If we consider the flower sample as a kind of initial leaf sample, the evolution of these nutrients is as to be expected (Sanz et al, 1993 a) from the knowledge we have about results only from leaf sampling. That is to say N, P and K levels continue to fall, whereas Ca and Mg rise, throughout the vegetative cycle.

The microelements Fe and Cu are found in greater quantities in flowers than in leaves, Mn in lesser and Zn in similar proportions.

The fact that a greater concentration of iron was found in flowers than in leaves and that the degree of variation of this element is also greater, could be of significance if it were possible to develop a method of early detection of iron chlorosis in pear trees (Sanz et al., 1992 b; Abadía et al., 1989)

Table 3 shows correlation and degree of significance between analytical results of flower samples and leaf samples taken 60 days after full bloom.

Table 4 shows correlation and degree of significance between analytical results of flower samples and leaf samples taken 120 days after full bloom (the standard time for leaf analysis in fruit trees).

It is clear from tables 3 and 4 that only Fe and Mn levels present in pear tree flowers and leaves show a significant correlation throughout the vegetative cycle up to 120 days after full bloom. These results contrast dramatically with those found for peach trees, in which all elements present in both flowers and leaves showed a close correlation. (Sanz et al, 1993 b)

As a result of these findings and by means of linear regression we can establish a number of equations which will allow us to predict the levels of Fe and Mn which we would expect to find in pear tree leaves taken 60 and 120 days after full bloom. (Table 5)

The physiological behavior of the pear tree presents particular features and obvious differences have been found with that of the peach tree, when studied using the same method. Therefore, we are led to believe that to form the basis of a complete floral diagnosis of the pear tree it will be necessary to particularize between varieties and differentiate growing techniques. We can say then, as a conclusion that:

1.-Floral diagnosis of pear trees enables us to predict the Fe and Mn content of leaves up to 120 days after full bloom.

2.-The wider degree of variance of Fe content of pear tree flowers, led us to believe that the analysis of this element could help detect the presence of iron chlorosis at an earlier stage than through leaf analysis.

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Table 1. Analytical results obtained from pear tree flowers.

<u>Elements</u>	<u>Content</u>		
	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
N%	3.477	3.948	2.856
P%	0.588	0.712	0.396
K%	1.949	3.010	1.390
Ca%	0.494	1.380	0.190
Mg%	0.288	0.406	0.227
Fe ppm	198.35	471.30	69.90
Mn ppm	27.74	52.20	14.40
Cu ppm	111.05	602.90	14.40
Zn ppm	48.99	188.00	18.30

Table 2. Analytical results obtained from pear tree leaves taken 120 days after full bloom.

<u>Elements</u>	<u>Content</u>		
	<u>Average</u>	<u>Maximum</u>	<u>Minimum</u>
N	2.337	2.912	1.316
P%	0.171	0.306	0.106
K%	0.839	1.920	0.210
Ca%	1.359	2.080	0.790
Mg%	0.356	0.529	0.203
Fe ppm	126.88	300.00	42.80
Mn ppm	47.94	125.40	13.60
Cu ppm	24.44	72.10	9.00
Zn ppm	58.72	194.70	10.30

Table 3. Correlation and significance (**99%) of nutrient contents of pear tree flowers and leaves taken 60 days after full bloom.

<u>N%</u>	<u>P%</u>	<u>K%</u>	<u>Ca%</u>	<u>Mg%</u>	<u>Fe ppm.</u>	<u>Mn ppm.</u>	<u>Cu ppm</u>	<u>Znppm.</u>
0,161	0,163	0,100	0,155	0,056	0,434**	0,427**	0,019	-0,096

Table 4. Correlation and significance (**99%) of nutrient contents of pear tree flowers and leaves taken 120 days after full bloom.

<u>N%</u>	<u>P%</u>	<u>K%</u>	<u>Ca%</u>	<u>Mg%</u>	<u>Fe ppm.</u>	<u>Mn ppm.</u>	<u>Cu ppm</u>	<u>Zn ppm.</u>
0,056	-0,136	0,082	0,088	-0,004	0,349**	0,341**	-0,079	0,118

Table 5. Linear regression equations to predict nutrient content of leaves taken 60 and 120 days after full bloom, based on flower analysis.

<u>Degree of freedom</u>	<u>Standard Error</u>	<u>Equation</u>	<u>Probability</u>
92	31.77	Fe(60d) =0.193Fe(fl) + 21.13	0.0001
93	45.74	Fe(120d) =0.215Fe(fl) + 85.18	0.0006
92	13.47	Mn(60d) =1.021Mn(fl) + 11.2	0.0001
93	21.26	Mn(120d) =1.243Mn(fl)+13.58	0.0008

Fe(60d) = Fe content of leaves taken 60 days after full bloom.

Fe(120d) = Fe content of leaves taken 120 days after full bloom.

Fe(fl) = Fe content of flowers.

Mn(60d) = Mn content of leaves taken 60 days after full bloom.

Mn(120d) = Mn content of leaves taken 120 days after full bloom.

Mn(fl) = Mn content of flowers.