NUTRITIONAL SITUATION OF PEAR ORCHARDS AFFECTED BY LATE FROSTS

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Abstract

This study was carried out in three 'Agua de Aranjuez' pear orchards located in the Alto Jalón area, which is regularly affected by late frosts.

Twenty trees were identified in each plot. Individual leaf samples were taken during 5 consecutive years and tree yields were recorded.

Based on the methodology for foliar diagnosis, the nutritional situation was defined in terms of N, P, K, Ca and Mg content and balance.

The information obtained showed potassium and calcium deficits resulting in a clear nutritional imbalance in that area. The situation is worsened for trees with higher relative yields (low yields in absolute terms), which may be due to the fact that the increased transfer of the deficient elements to the fruit results in a further reduction of leaf levels.

1. Introduction

In the area under study (Alto Jalón) there are about 2.000 ha devoted to pear growing, 60% of them belonging to the variety 'Agua de Aranjuez' (DGA, 1985). Yield levels, however, are very low mainly due to late frosts that occur virtually every year.

The aim of this study was to determine to what extent do late frosts affect the nutritional situation of the trees, namely with regards to N, P, K, Ca and Mg.

2. Material and methods

In order to conduct the study, three 6-year-old 'Agua de Aranjuez' pear orchards, two of them on Provence quince and one on seedling, were selected. Twenty trees were identified in each of them and included in the study.

The three orchards are planted on alkaline, slightly calcareous, fertile soils (Table 1).

During 5 consecutive years leaf samples were taken in the second fortnight of July, and the individual yield of each tree was recorded.

After removing the petioles, the collected material was washed, dried and ground, and then analyzed following the methods proposed by the Intersynstitute Committee for leaf analysis (Pinta, 1973).

As the study was conducted in an area where the endemic frosts affect yields significantly (yields are less than 50% the normal values to be expected from the species and variety), the method of multiple binary ratios proposed by Recalde (1965) was used to diagnose the nutritional situation. Recalde indicates that this approach makes

it possible to have a better estimate of the optimum nutritional situation, as the external effects, such as age of the orchard, rootstock, variety, climate, soil, etc., are minimized.

3. Results and Discussion

With the analytical data (300) from the 5-year period the values of the 10 binary ratios were estimated: N/P, N/K, N/Ca, N/Mg, P/K, P/Ca, P/Mg, K/Ca, K/Mg and Ca/Mg.

These values were distributed in 7 intervals, and the individual yields of each tree included in the intervals were used to determine the correspondence between both parameters. Table 2 shows the intervals of each binary ratio in which maximum yield is obtained, and the mean value of these intervals.

With these mean values and taking each element as the unit, the corresponding amount of the other elements is estimated (Table 3), which allows establishing the proportionality rate (Table 4 and 5).

The mean values of these balances (represented in Figures 1, 2 and 3) may be considered to be optimum for the area, as they have been estimated for the trees giving the highest yield. In our study, a clear imbalance is observed in that situation.

Indeed, in Figure 1, which also includes the balances estimated from the optimum and/or average contents as found in the literature, we can notice that there is too much N involved in the overall nutrition (53%), versus 34-47% proposed by different authors. This relative nitrogen surplus occurs at the expense of potassium (19%) and calcium (15%). Mg is present at a slightly higher (10%) rate than that estimated based on the reference contents.

When considering the nutrient balances in groups of three (figures 2 and 3) this anomaly becomes still more evident. Thus, the nutritional situation of 'Agua de Aranjuez' pear trees shows excess nitrogen and potassium deficit (Figure 2), but regarding the balance of potassium with Ca and Mg (Figure 3), its proportion is only slightly lower than that reported in the literature. Calcium and magnesium, however, are clearly imbalanced in that ratio, with a high Mg and low Ca content.

When applying the same estimation methodology with the intervals corresponding to the trees with the lowest yield, the nutritional situation gets closer to that reported as optimum or normal in the literature. Figure 1 shows that the percentage contributions of these five nutrients to the tree nutrition are in agreement with the values proposed in the literature. The N:P:K balance (Figure 2) is the opposite of the nutritional situation of trees with maximum yields, as there is a relative nitrogen deficit and a relative surplus of potassium. Finally, with regards to the K:Ca:Mg balance (Figure 3), Mg presents a normal level, potassium is in relative excess and calcium shows a deficit.

If we now examine the mean contents in the balance between all the five nutrients, we can see that nitrogen, phosphorus and magnesium show levels very similar to those considered as optimum and/or average in the literature, while calcium and potassium are at much lower concentrations (Table 6).

For this reason, when considering the N:P:K balance (Figure 2), and taking into account the low contribution of phosphorus to the overall nutrition, the nutritional situation shows that there is excess nitrogen, but only in relative terms, as it is due to the low potassium level. However, when we consider the K:Ca:Mg balance (Figure 3), since the K and Ca contents are low, as stated above, the situation turns against the lowest one (calcium) and in favour of the nutrient with a practically normal level (magnesium).

This study clearly shows that calcium and potassium are the most adversely affected elements, and for this reason correcting the nutritional situation will result in increasing the contribution of these two nutrients to the tree nutrition.

However, bearing in mind that these orchards are regularly fertilized by the farmers and considering the nutrient levels found in the soil, there is not much ground to believe that the problem would be solved by adding more of these nutrients when fertilizing; rather, we should expect frosts to block the plant nutrient uptake mechanisms.

The contrast between the trees with the highest yields and those with the lowest ones enables us to further clarify some of the considerations stated above. On the one hand, the greater significance of calcium deficit is confirmed, as its concentration in the leaves does not tend to return to normal even in the trees with lowest yields, which suggests that this is a general problem in that area with respect to potassium, its relative surplus in the trees with low lowest yields may be due to the poor potassium transfer to the fruits.

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Table 1 - Characteristics of the soils

	pH	CO ₃	MO ⁽¹⁾	N	P ⁽²⁾	K ⁽³⁾	Ca	Mg
Plot 1 Soil	8.0	18.8	1.91	0.162	40.0	60.-	0.43	0.09
Subsoil	8.3	18.6	1.50	0.126	12.8	25.-	0.41	0.09
Plot 2 Soil	8.1	22.1	1.46	0.123	12.8	31.5	0.44	0.07
Subsoil	8.2	21.2	1.30	0.109	6.2	19.2	0.45	0.08
Plot 3 Soil	8.2	11.1	1.27	0.104	42.0	37.0	0.42	0.04
Subsoil	8.3	9.0	0.83	0.070	30.2	29.2	0.38	0.04

(1) %

(2) mg P₂O₅/100 g soil

(3) mg K₂O/100 g soil

Table 2 - Intervals and mean values of the binary ratios corresponding to the trees with maximum yields

Ratio	Optimum ratios		Mean value (Int.)
	I n t e r v a l		
N/P	16.23	17.51	16.870
N/K	2.63	2.91	2.770
N/Ca	2.61	3.24	2.925
N/Mg	5.93	7.58	6.755
P/K	0.16	0.17	0.165
P/Ca	0.21	0.24	0.225
P/Mg	0.37	0.45	0.410
K/Ca	0.82	1.95	1.385
K/Mg	1.00	2.70	1.850
Ca/Mg	1.26	1.86	1.555

Table 3 - Amount of nutrients corresponding to each of the 5 elements taken as the unit

Reference Element	Corresponding value				
	N	P	K	Ca	Mg
N	1.0000	0.0593	0.3610	0.3419	0.1480
P	16.8700	1.0000	6.0606	4.4444	2.4390
K	2.7700	0.1650	1.0000	6.7220	0.5405
Ca	2.9250	0.2250	1.3850	1.0000	0.6431
Mg	6.7550	0.4100	1.1500	1.5550	1.0000

Table 4 - Sum of contents (N+P+K+Ca+Mg) for each element taken as reference and nutritional balance

Reference Element	N+P+K+Ca+Mg	N:P:K:Ca:Mg
N	1.9102	52:3:19:19:8
P	30.8140	55:3:20:14:8
K	5.1915	53:3:20:14:10
Ca	6.1781	47:4:22:16:10
Mg	11.5700	58:4:16:13:9

Table 5 - Sum of contents (N+P+K) and (K+Ca+Mg) for each element taken as reference and nutritional balance

Reference Element	N+P+K	N:P:K:	K+Ca+Mg	K:Ca:Mg
N	1.4203	70:5:26		
P	23.9306	70:4:26		
K	3.9350	70:4:26	2.2625	44:32:24
Ca			3.0281	46:33:21
Mg			4.4005	42:35:23

Table 6 - Mean nutrient content and overall nutrition of 'Agua de Aranjuez' pear trees in the area under study and optimum or average values as reported in the literature.

N	P	K	Ca	Mg	N+P+K+Ca+Mg	N+P+K	K+Ca+Mg	Referencia
2.88	0.16	1.22	1.00	0.38	5.04	3.66	2.60	Area study
2.50	0.17	1.60	1.80	0.40	6.47	4.27	3.80	(1) Leece
2.20	0.20	1.50	1.50	0.50	5.90	3.90	3.50	(2) Dăvidescu
2.33	0.28	1.53	1.40	0.41	5.95	4.14	3.34	(3) USA (cit. Gautier)
2.40	0.20	1.30	1.00	0.25	5.15	3.90	2.55	(4) E.B. (cit. Gautier)
2.80	0.25	1.60	1.60	0.30	6.55	4.65	3.50	(5) Bould (cit. Gautier)
2.25	0.15	1.50	1.40	0.22	5.52	3.90	3.12	(6) Francis (cit. Gautier)
2.35	0.20	2.00	2.00	0.35	6.90	4.55	4.35	(7) B. Gobain (cit. Gautier)
2.25	0.225	1.50	1.50	0.25	5.73	3.98	3.25	(8) Vang Petersen (cit. M. Prevel)
2.55	0.225	1.60	1.50	0.375	6.25	4.375	3.475	(9) Bergmann

Figure 1

Figure 3