REDUCED NUTRIENT UPTAKE IN PEACH TREES TREATED WITH PACLOBUTRAZOL

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Abstract

Paclobutrazol (Pbz) is a triazol that effectively inhibits vegetative growth in peach. Changes in mineral element concentration have been generally found. However, uneven distribution of the elements in the soil may partially account for these differences. The trees were treated with 2 g Pbz/tree shortly AFB. Reductions of 40% in leaf area and of 29% in dry weight were recorded in Pbz-treated peach. Nutrient concentration on dry weight basis varied little (about 11%). However, global assimilation of nutrients on a leaf basis, when compared with controls, decreased up to the same extend as dry weight (25%). From these results it can be inferred that the mineral fertilization in Pbz-treated peach trees can be reduced to the same extend as the expected reduction in vegetative growth, consequently reducing production costs and environmental contamination.

Additional key index words: Peach, paclobutrazol, growth regulators, mineral nutrients, leaf area, dry matter, *Prunus persica* L. Batch

1. Introduction

The requirements of the market for high-quality products are translated, in cultural terms, in the need for producing fruits of high quality at low cost. This induces the fruit grower to introduce cultural practices that permit to obtain that objective. Among these practices, technical personnel highlight, fruit thinning, standard usage of dwarfing rootstocks, pruning and additionally the application of growth regulators to maintain the size of the tree within some levels that give cause for low cultivation costs.

Paclobutrazol (Pbz) is a triazol that effectively inhibits vegetative growth in peach. Changes in mineral element concentration have been generally found. However, uneven distribution of the elements in the soil may partially account for these differences. To ascertain these effects, an experiment was designed under controlled conditions, in which sugar beet, used as a model plant, was grown hydroponically, treated with Pbz and the results compared to those from peach trees grown in the open.

They have been found discrepancies in sensitivity depending on the different varieties, on the rootstocks that are grafted and on the environmental conditions (Davis et al., 1988). It is being observed, furthermore, that the crop load interacts with paclobutrazol varying the inhibition level of the shoot growth provoked by the growth regulator according to the number of fruits carried by the tree. Rieger (1990) working in hydroponics on nemaguard peach rootstocks, found that Pbz treatment induced decreases in N, P, K, Fe and Mo, whereas levels of Ca, Mg, B and Mn were increased by Pbz. This author stated that the magnitude of changes in foliar nutrition were proportional to the

degree of growth suppression. In the case of Fuji apple trees, Huang et al. (1995) found that the differences in the total dry matter accumulated per kg of leaves were negligible. On the other hand, in mango, the leaf content of N, Ca, Mn, Zn and B contents increased by Pbz treatment while P, K and Cu decreased (Werner and Schaffer, 1993).

Triazols influence root growth and morphology, therefore they can alter the mineral uptake, that is to say, plant nutrition. Sometimes authors found discordant results among them. This fact can be attributable to the different environmental conditions, plant species or varieties, etc. However, attending the morphological changes suffered by the plants treated with Pbz, and specially those of the leaves (leaf area and thickness), it is obvious that the data are subjected to other multiple sources of variation (intensity of applications, doses, time of application, etc.). Therefore, it is not surprising that authors as Wang et al. (1985) observed that the Pbz-treatments increase the content of N, P, K, C, Mg, B, Zn and Sr in leaves of pear tree. Rieger and Scalabrelli (1990) demonstrated in peach tree, that the foliar concentrations of N, P, K, Fe and Mb decrease slightly, while increase those of C, Mg, B and Mn. On the contrary, results from Wieland and Wample (1985), in apple tree and ours, in peach tree, indicate that the Pbz does not influence the foliar content of N, P, K, and Mg. As it seems, the general trend, in the studied materials, is the lack of variation in the leaf concentration of macroelements when results are expressed in a dry matter basis. In any way, Atkinson (1986), among other, asserts that growth regulators produced greater modifications in the vegetative growth than in fruits. It probably implies increases in demand for certain elements and additional decreases of other. This last assert also coincides with our previous results. In the sense, the only element that increases spectacular and significantly its concentration in peach tree leaves is Mn (Monge, et al., 1993, 1994).

In general, it has been observed that a decrease of the provoked vegetative growth, by dwarfing rootstocks, as well as by the application of growth inhibitors, implies an increase in the productivity. These results indicate that the fruits are organs more powerful than the shoots in the uptake of water and nutrients. Accordingly, Zhou and Ye (1996) concluded that the inhibition of the vegetative growth gives cause for increments in the tree productivity. The dispersion of the nutrientes among the different organs depends on the ability of these organs for the mobilization of the sources that produce compounds (Daie, 1985).

2. Material and Methods

2.1. Peach trees

The experiment was carried out on a peach tree orchard located in Fuentes de Ebro (NE Spain) belonging to the ALM group. The orchard consisted on adult trees cv Catherine. The trees were planted on sandy-franco soil with 0.95% organic matter, pH 8.1, being submitted to the normal cultural practices applied in the area, including flooding irrigation. The experiment was performed on homogenous trees being their average trunk girth of 35.3 ± 2.7 cm

The peach trees were treated with 2 g Pbz/tree shortly AFB, and the leaves were harvested from trees without crop along the summer 1991. In all cases, the Pbz solutions were prepared by solving the appropriate quantity of the commercial compound (Cultar,

ICI) in 1 L of distilled water. The treatment was applied by pouring the solution to the soil around the trunk.

2.2. Leaf Area

50 leaves per treatment were measured for their area by an image analyzer (*Area Measurement System*, ΔT Devices Ltd., Burwell, Cambridge, England)

2.3. Specific weight

A single disk of known area (1.767 cm^2) from 10 leaves per treatment was taken (total area 17.67 cm^2). These ten disks were weighted to have the fresh weight and then were dried during 48 h at 60°C to get the dry weight. The specific weight or leaf index was given by the value of the ratio *dry weight/total area*.

2.4. Sample preparation

The leaves were dried in a furnace under hot air at 60°C during 48 hours. They were grounded and homogenized through a 60 mesh sieve. 1 g of this material was dry digested in a furnace (600°C) during 24 h, and the ashes dissolved in nitric acid (1:1). The solution obtained was evaporated until total dryness and the residue was again furnace for 1 hour at 600°C . The ashes were dissolved by heating with diluted HCl.

2.5. Analysis of mineral nutrients

K was determined by atomic emission spectroscopy in a Unicam 929. The rest of elements except P were quantified by ICP-AES (*Jobin-Yvon*. Mod. JY-38). Nitrogen was determined by Kjeldahl'.

3. Results and Discussion

From Davis et al. (1988) numerous authors agreed about the need for studying how triazols modify plant nutrition: - " their effects in nutrition are of minor relative importance, it is possible that the triazol treatments influence the needs for fertilization " - . Growth regulators are used in agriculture to increase yield or quality of crops through the inhibition of the plant vegetative growth. It has also been postulated that alter plant metabolism by modifying physiological key process as the nitrogen fixation, uptake of mineral nutrients, senescence and photosynthesis (Gianfagna, 1988).

Table 1 shows the parameters describing the leaf morphology of peach trees treated or not with Pbz. Pbz peach leaves suffered a dramatic decrease of their leaf area (40% for peaches and 84% for sugar beet). However, these same leaves have to be thinner than those of control attending the decrease in their specific dry weight (18% for peach and 83% for sugar beet, respectively).

Table 1. Leaf area, dry weight on a leaf area basis and their variation percentage in peach trees and sugar beet.

<i>PBZ dosage</i>	<i>Leaf area cm²</i>	<i>Dry weight mg cm⁻²</i>
0 g·tree ⁻¹	34.63	6.36
2 g·tree ⁻¹	20.67	7.54
% Variation	-40.32	18.53

As the number of leaves in Pbz-treated peach trees do not increase, it is obvious that the canopy of the treated trees must be heavily modified. Previous results (Blanco, et al., 1989) also shown that neither the yield nor the number and weight of the fruits are detrimentally affected by the Pbz treatments. Therefore, it seems that the treated trees can perform photosynthesis at a rate high enough as to supply the fruits with the necessary photoasimilates that permit to have a proper development. Assuming that the Pbz-trees carry the same number of leaves than controls, and having into account the reduction in the total foliar dry matter, modifications in the mineral nutrient uptake can be expected.

When leaf mineral contents are exposed in a dry matter basis (Table 2), global nutrition of the controls trees quantified as the summa of N, P, K, accounts for 4.65% of the total dry matter, while in Pbz trees the value is 4.38%. The other macroelements Ca and Mg increased their leaf content per dry weight in the treated trees (27 and 8.7% respectively), and regarding the micronutrients Fe and Mn increased by a 38% and Zn and Cu decreased slightly.

Table 3. Concentration of mineral nutrients on leaf area basis ($\mu\text{g}\cdot\text{cm}^{-2}$) in Pbz-treated and untreated peach trees

<i>PBZ dosage</i>	<i>Ca</i>	<i>Mg</i>	<i>K</i>	<i>P</i>	<i>N</i>	<i>Fe</i>	<i>Mn</i>	<i>Zn</i>	<i>Cu</i>
0 g·tree ⁻¹	152.3	36.8	87.1	8.8	200.0	0.87	0.29	0.16	0.10
2 g·tree ⁻¹	229.7	47.4	88.5	11.2	231.1	1.42	0.49	0.20	0.12
% Variation	50.8	28.9	1.66	26.60	15.5	62.5	65.2	22.0	13.2

However, as stated above the Pbz-treated trees have smaller and thicker leaves, therefore, it could be more accurate the expression of their mineral concentrations as a function of the leaf area (Table 3). In this case, global nutrition of controls accounts for $295.9 \mu\text{g cm}^{-2}$, while for treated trees this value increases up to $330.8 \mu\text{g cm}^{-2}$. The rest of nutrients including Ca, Mg and all micronutrients also increase respect to controls.

It is difficult to elucidate the more convenient way to reflect the nutritional status of plants treated with Pbz. In this way, we propose to express the analytical data as a function of the whole leaf. That is to say, the total amount of each nutrient per leaf unit (Table 4). In this way, taking the single leaf as reservoir of nutrients, K+P+N on Pbz-trees was 10.25 mg per leaf and 6.84 on controls. The rest of nutrients also deceased but in a lower extent.

Table 4. Contents of mineral nutrients on a leaf basis in peach trees. Results expressed in mg.leaf⁻¹ for *Ca*, *Mg*, *K*, *P* and *N*, and as µg.leaf⁻¹ for *Fe*, *Mn*, *Cu*, *Zn*

<i>PBZ dosage</i>	<i>Ca</i>	<i>Mg</i>	<i>K</i>	<i>P</i>	<i>N</i>	<i>Fe</i>	<i>Mn</i>	<i>Zn</i>	<i>Cu</i>
0 g·tree ⁻¹	5.27	1.27	3.02	0.31	6.92	30.29	10.20	5.60	3.54
2 g·tree ⁻¹	4.75	0.98	1.83	0.23	4.78	29.38	10.05	4.08	2.39
% Variation	-10.0	-23.1	-39.33	-24.44	-31.0	-3.0	-1.4	-27.2	-32.5

All trees studied were healthy and it seemed that the expression of nutrient concentration in a dry matter basis does not reflect the actual nutritional status of the Pbz-trees. The contents calculated in this way are not proportional either to the recorder diminution on the leaf area or on the specific leaf dry weight. Similarly, when concentrations are given per leaf area the lack of proportion between leaf area or dry weight and the nutrient concentrations is evident. Only, when the analytical results are given per single leaf, a good agreement between leaf dry weight per area unit and the amount of nutrients are closely related.

From these results it can be inferred that the mineral fertilization in Pbz-treated peach trees can be reduced to the same extend as the expected reduction in vegetative growth, consequently reducing production costs and environmental contamination.

4. References

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