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Comparison of "Declinamiento", "Blight", "Declinio", and "Marchitamiento Repentino" by Use of Uniform Examination Methods

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ABSTRACT. Tests were performed in declining orange groves in different parts of the American continent to determine, if and to what extent the disease characteristics coincided. "Declinamiento" in Calderón sweet orange, on trifoliolate orange rootstock, in Montecarlo, Misiones, Argentina; "Blight" of Hamlin and Pineapple sweet orange on rough lemon, at different locations in Florida, USA; "Declinio" in Valencia grafted on Rangpur lime, in a plantation near Conchal, São Paulo, Brazil; decline diseases of similar phenology in Valencia sweet orange on trifoliolate orange in Saladas, Corrientes, Argentina and Concordia, Entre Rios, Argentina; "Marchitamiento Repentino" in trees of the same combination near Salto, Uruguay; as well as citrus ringspot (CRSV)-diseased Valencia/rough lemon in Eldorado, Misiones, Argentina were analyzed using the following techniques: gravity water injection in the trunkwood by 4 independent units per plant, characterization of the soil condition at the experimental sites, determination of the zinc level in the scion trunk wood, inspection for pathogenic alterations and verification of the starch content above and below the budunion, and check of the root system for decay occurrence. Significant differences between the investigated types of decline could not be detected.

In various parts of both Americas citrus declines of unknown etiology exist. Some of them appeared only recently, others have been under study for a long time, although with limited success with regard to the detection of their origin or their practical control. One question still pending is whether different names like "declinamiento", "blight", "declinio", or "marchitamiento repentino" stand for different diseases or are different expressions of the same disease. To investigate this, a series of uniform tests were undertaken in different regions, where citrus decline occurs.

Table 1 lists some features thought to be specific for the mentioned types of decline. Their predominance on certain scion-rootstock combinations merit special attention. We tried to find out, if the one or the other external or internal characteristics of the affected plants confirmed these differences.

RESULTS

Water injection. Waterflow ex-

periments were performed at all experimental sites as gravity injections with 4 independent units per tree (fig. 1).

We were surprised by the great variation of the water uptake rates, not only between individual trees, but also within single trees. Diseased plants are sometimes affected in only one sector, which could account for the irregularities in the water uptake. It is hard to explain, however, why this also occurred with trees rated healthy. Furthermore, we could not find a close correlation between disease rating and water uptake. The waterflow rates obtained in Florida, USA with a single injection unit per tree were similarly inconsistent.

A noteworthy finding in the tests was the extremely reduced water uptake of citrus ringspot (CRSV)-infected trees of Valencia sweet orange on rough lemon rootstock. This is not surprising, since the xylem vessels of severely diseased trees are completely blocked by gum deposits. However, low water uptake was also recorded on

TABLE 1
GENERAL CHARACTERISTICS OF SOME TYPES OF CITRUS DECLINE

Disease	Scion/rootstock combinations known to be susceptible	Scion/rootstock combinations considered resistant	Onset and spread of decline	Regional distribution
Declinamiento	sweet orange on trifoliolate orange, minor incidence on citrange	sweet orange on rough lemon, Rangpur lime, Cleopatra, sweet orange; grapefruit and tangerine on all rootstocks	appears from 2 years on; spreads rapidly to the entire plantation	general in Misiones
Blight	mainly sweet orange or grapefruit on rough lemon; also known on Rangpur lime, trifoliolate orange and citrange	sweet orange, grapefruit or tangerine on sweet orange, Cleopatra or sour orange	appears from 6 years on, usually after 10-12 years; spreads rather slowly, affects isolated or groups of trees, but exceptions are known	more prevalent in southern Florida
Declinio	mainly sweet orange on Rangpur lime, but also on rough lemon, trifoliolate orange or Volkamer lemon; decline of grapefruit, lime and tangerine are known	sweet orange and other scions on sweet orange, Cleopatra, Sunki or Orlando tangelo	appears from 4 years on; in general spreads slowly; occurs mostly on isolated trees or in pockets	principally in some areas of the state of São Paulo, Brazil; may be advancing
Marchitamiento repentino	known mainly on sweet orange on trifoliolate orange; suspected cases of grapefruit on trifoliolate orange and sweet orange on rough lemon exist	sweet orange on trifoliolate orange outside susceptible areas and sweet orange on other combinations	appears from 6-10 years on; comparatively slow spread; occurs on isolated trees or in pockets	prevails on sites with heavy clay soil; on calcareous subsoil in the areas of Concordia and Uruguay

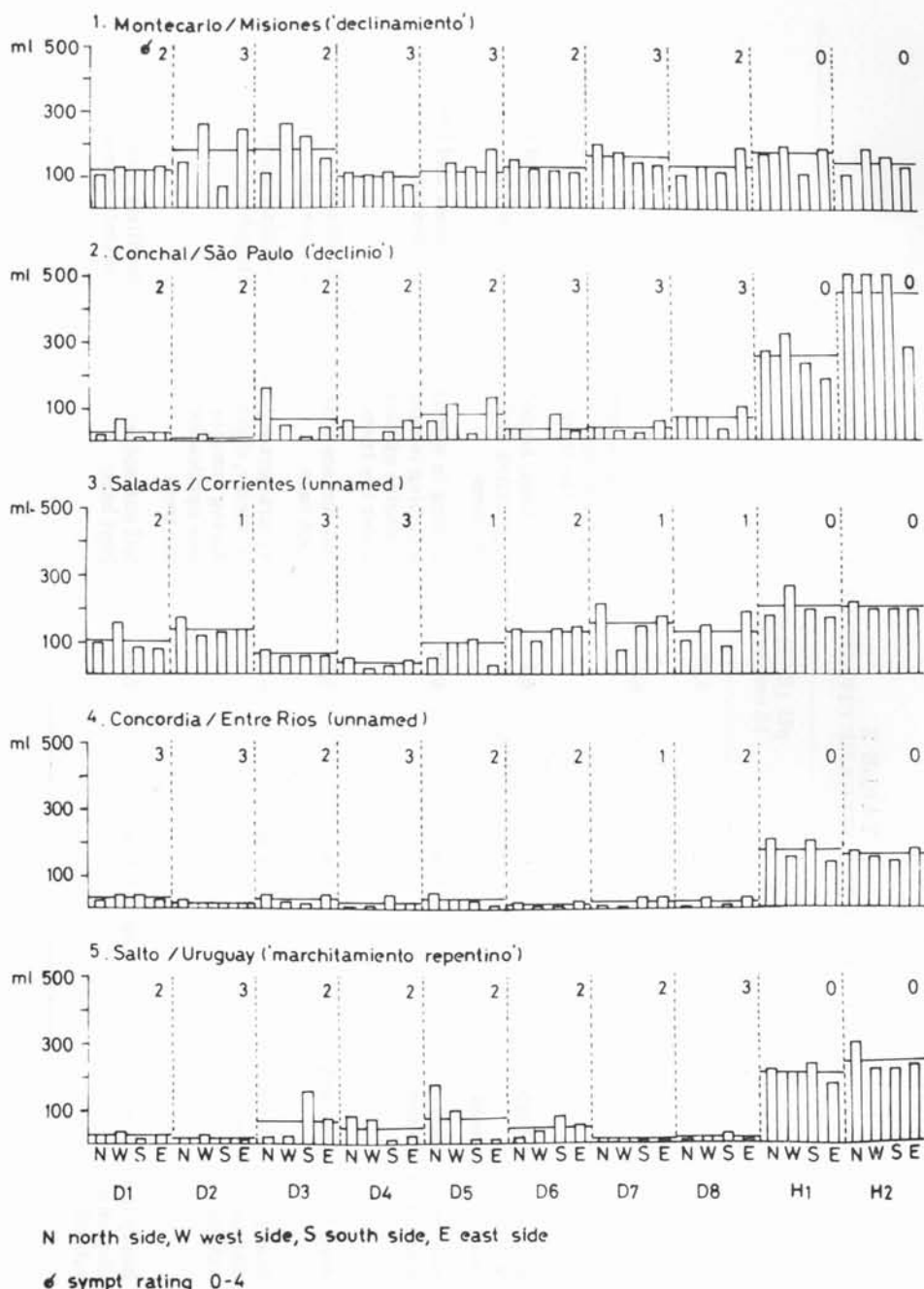


Fig. 1. Water uptake of declining (D1-8) and apparently healthy (H1-2) sweet orange trees in South America from gravity injection at four sites on the scion trunk. Starting volume was 500 ml and the injection period was 24 hours. Canopy decline severity was rated on a scale of 0 = healthy to 4 = severe.

vigorous and symptom-free control trees in the same lot. CRSV-infection could have interfered at the experimental sites in Saladas, Corrientes; Concordia, Entre Rios,

and Salto, Uruguay, even though we avoided CRSV-suspect trees.

Soil condition. It has been assumed that "blight" is a physiological disorder, for which the soil

TABLE 2
SOIL CONDITION AT DIFFERENT SITES OF CITRUS DECLINE OCCURRENCE

Site of experiment	Soil type	Root penetration	pH (KCl) at 15 cm depth	Soil cultivation (weed management)	Soil amendment
Montecarlo, Misiones ("declinamiento")	deep red lateritic soil, well drained	1 m	4.10	soil surface constantly kept bare	none
Central Florida (ridge) ("blight")	deep sandy soil	1 m	6.5	disking in winter, mulching in summer, herbicide application under the trees	fertilizer and lime application
Southern Florida (flatwoods) ("blight")	shallow sand, high water table, calcareous subsoil	0.5-1 m	6.5	mulching, herbicide application under the trees	fertilizer and lime application
Conchal, São Paulo ("declinio")	red-yellow sandy loam, well drained	0.5-1 m	4.05	disking in winter, mulching in summer, herbicide application under the trees	fertilizer and lime application
Saladas, Corrientes (unnamed)	deep light sandy soil	1 m	4.00	soil surface constantly kept bare	fertilizer application
Concordia, Entre Rios (unnamed)	heavy dark colored clay on calcareous subsoil	up to 0.4 m	6.01	natural grass cover in winter, disking during summer, herbicide application under the trees	fertilizer application (no phosphate)
Salto, Uruguay ("marchitamiento repentino")	heavy dark colored clay on calcareous subsoil	up to 0.6 m	4.75	soil surface constantly kept bare	fertilizer application (mainly nitrogen)

condition is an important factor (3). However, there are no common characteristics of all sites of "blight" development, and the attempts to change the soil condition in order to control "blight" did not yield consistent results. Today, there is a strong tendency to believe, that "blight" or "declinio" or "declinamiento" are not associated with a specific soil condition (1).

Our records suggest the same interpretation. A different situation appears to exist in Concordia and neighboring Uruguay, where cases of "marchitamiento repentino" are limited to pockets of heavy, dark colored loamy soil on a calcareous subsoil. A decline problem does not exist in areas of light sandy soil in Entre Rios, even though 75% of the orange plantations consist of the susceptible combination of Valencia sweet orange on trifoliolate orange rootstock. On the other hand, decline does occur on the same sandy soil in a fertilizer experiment at the INTA experiment station of Concordia, but only in the plots which received lime application.

Zinc levels in the scion trunk wood. The accumulation of zinc in the trunkwood just above the budunion is generally accepted as an indicator of "blight" and similar citrus declines (4). In fact, high zinc levels have been one reason to group these maladies together (5). In the results of our zinc analyses, we again found considerable inconsistency (fig. 2). In Florida, the differences between affected and healthy looking trees appeared a little more pronounced, but also with great variation. As in the water uptake experiment, citrus ringspot infected Valencia orange trees on rough lemon rootstock behaved like decline-affected trees, with abnormally high zinc levels.

Starch content in the trunkwood of scion and rootstock. The

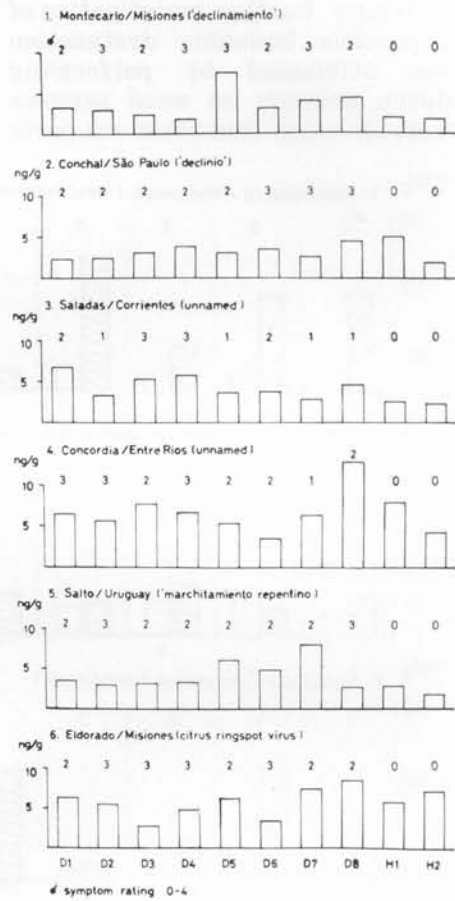


Fig. 2. Zinc levels in scion trunk wood samples collected from declining (D1-8) and apparently healthy (H1-2) sweet orange trees in South America. Canopy decline severity was rated on a scale of 0 = healthy to 4 = severe.

fact, that "declinamiento" in Misiones is limited to trees with sweet orange scions and trifoliolate orange rootstock (or their hybrids), whereas lemons, tangerines and grapefruit on the same rootstock are not affected, indicate a combination-specific effect. Successful inarching of declining orange trees with other rootstocks support this interpretation. Sufficient reason existed therefore, to look for the presence of a budunion disorder. However, visual inspection of the budunion zone of every tree in each experiment did not reveal evidence of an ab-

normality. Further investigation of a possible budunion dysfunction was attempted by performing starch analysis on wood samples from the scion- and rootstock parts

of the trunk of all examined trees in South America (fig. 3). The data obtained permitted these conclusions: a) In general, apparently healthy trees contain more starch

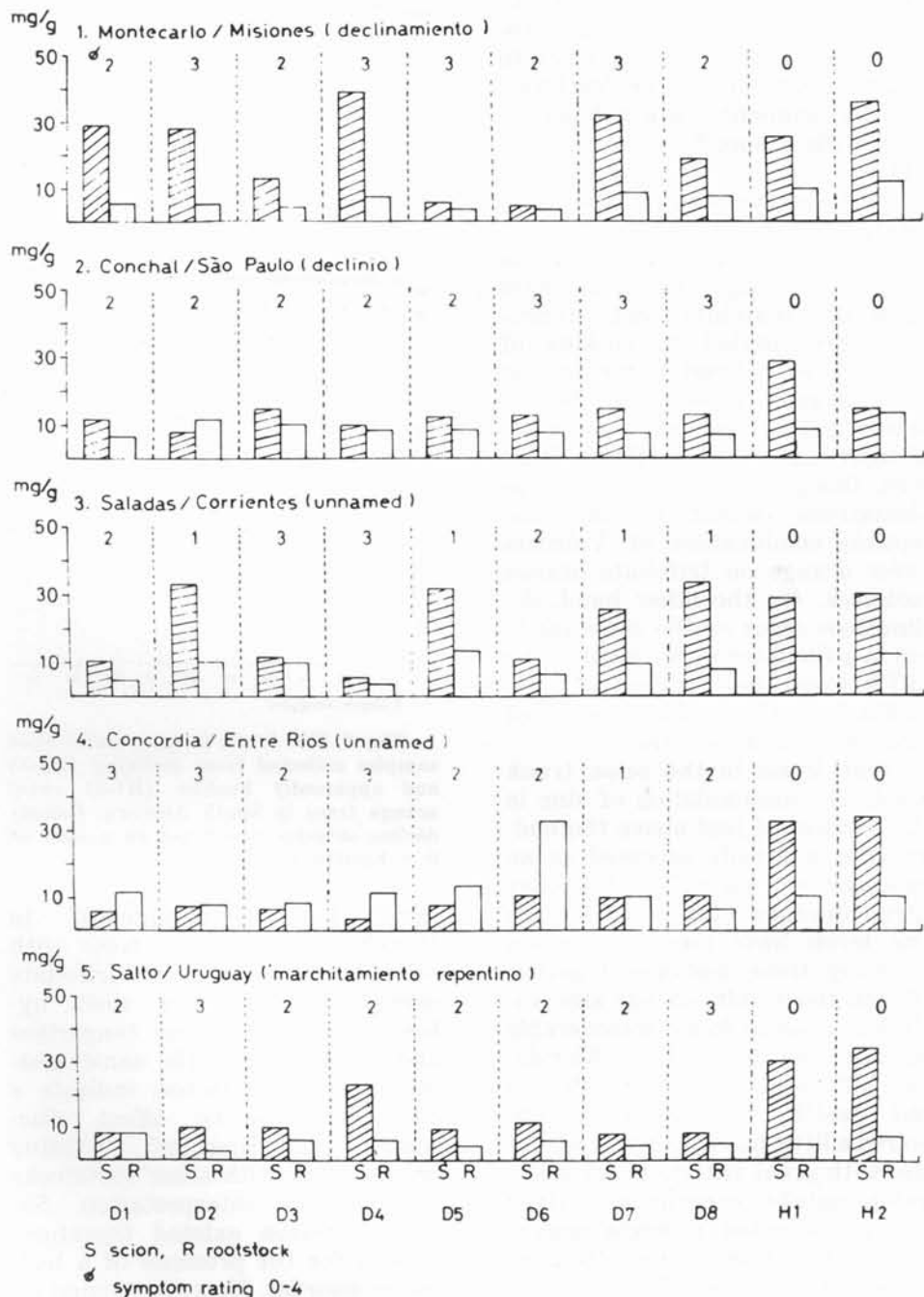


Fig. 3. Starch content of scion and rootstock trunk wood samples collected from declining (D1-8) and apparently healthy (H1-2) sweet orange trees in South America. Canopy decline severity was rated on a scale of 0 = healthy to 4 = severe.

than decline-affected trees, but with great variation. b) Trees with "declinamiento" apparently have higher starch levels in the rootstock than healthy controls. 3) In the Concordia experiment we found a higher starch content in the rootstock than in the scion trunk wood. The starch patterns of "blighted" trees in Florida resemble those of the South American samples.

Histological examination of the bark tissue at the budunion. In histological examinations of bark samples cut across the budunion from all trees in South America we did not detect pathological phenomena with reasonable consistency to account for the severe dieback of the trees. In particular, there was no perceptible difference between samples from obviously affected and apparently healthy trees. These findings do not confirm statements in earlier reports (2).

Occurrence of root rot on decline-affected trees. Root rot of what we believed to be the same type was found on affected trees in all experiments. It was most severe on "declinamiento"-diseased trees in Misiones. The intensity of root rot appears to coincide with the severity of decline. Often, however, no rot was found in the incipient stage of decline, suggesting that root rot probably is not the primary stage of the disease. *Fusarium solani* has been isolated from "blight"- and "declinamiento"-affected trees consistently.

DISCUSSION

None of the tests applied confirmed the current distinction between regional types of citrus decline. Considerable reason exists to believe, that "declinamiento" in Misiones predominates on sweet orange grafted on trifoliate orange, because nearly all of the plantations consisted of this combination, the same could apply for sweet orange

on Rangpur lime in Brazil and—to a lesser extent—for sweet orange on rough lemon in Florida. However, there is a considerable variability in our results, which does not always allow differentiation between declining and healthy appearing trees. The reason might be, that all applied tests examine secondary effects, i.e. xylem plugging, root decay, starch or mineral translocation, which probably are conditioned by a complex range of factors.

The combination of various characteristics, however, permits a more reliable diagnosis (fig. 4).

The fact, that a virus infection like citrus ringspot, with similar phenological appearance reduces the water uptake and induces zinc accumulation in the trunkwood, has to be considered in future investigations.

In spite of their heterogeneity, our findings are of interest. If "declinamiento" is identical to "blight", epidemiological studies should be carried out in Misiones, because of the high disease incidence and early symptom appearance.

A still unsolved question is the situation in Concordia and Uruguay. This might indicate, that other unknown factors exist, which remain to be revealed.

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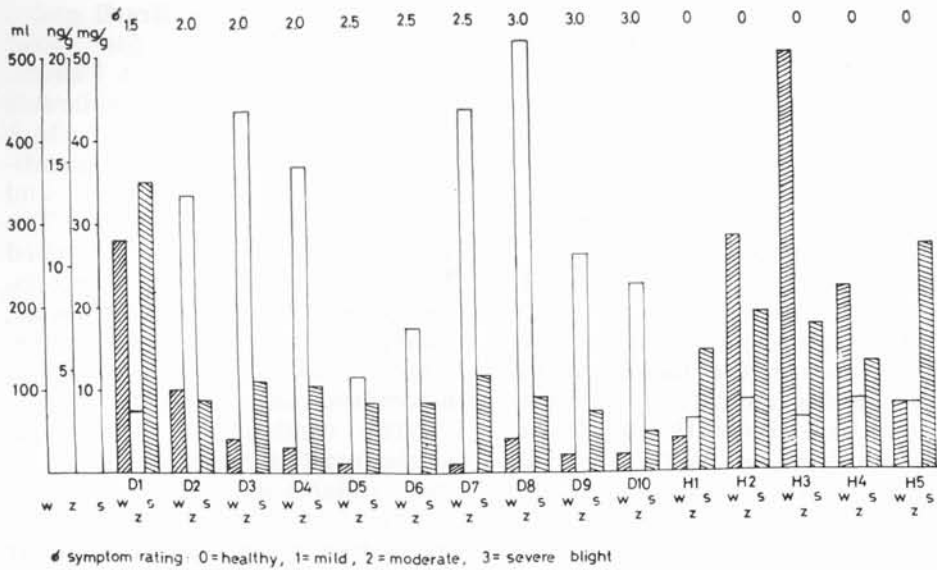


Fig. 4. Water uptake (w), zinc level (z), and starch contents of scion trunk wood of blight-affected (D1-10) and apparently healthy (H1-5) sweet orange trees in Florida, USA.

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