農化學會誌 第五號, 1964

Studies on The Nutrition of Apple Trees with Reference to The Bark Necrosis Disease

Park, Young-Dae, Kim, Yung-Sup, Lee, Dong-Suk
朴 永 大·金 泳 燮·李 東 碩

農村振興廳 農化學科
(1964年 3月 26日 受理)

Recently, an unknown apple bark disease occurs cheifly on the variety of Rolls Jenet in Korea. Diseased trees are unthrifty and sometimes the whole tree may die and the disease caused serious losses in product. The bark disease is not transimissible and consequently not induced by the bacteria, fungi, or viruses. But the cause of the bark disease has not been determined with certainty. Generally, physiological studies indicate that it may be due to mineral unbalance.

The purpose of this experiments examined by the method of foliar diagnosis is to determine the leaf nutrient element composition between healthy and diseased trees.

Review of Literature

Considerable confusion existed among the workers who encountered similar apple bark disease. Berg[4] in 1934 classified the bark disease into three categories; One caused by the fungus Helminthosprium Papulosum. Berg named this disease "Black pox" He gave the name "Apple meals" to another disease which was found most often on the York variety. The third type of bark condition named "Internal Bark Necrosis." In 1934 when Berg described this disorder, he was unable to established its cause and since then many workers have shown interest in this field. For instance, in 1937 Yung and Winter[26] stated that disease apparently was caused by boron deficiency. This conclusion was confirmed in 1939 by Hildenbrand.[4] In 1964 Berg and Clulo,[3] using boron free sand culture, showed that they have been unable to produce any necrotic lisions or other symptoms thyical of Internal Bark Necrosis and they showed that the disease apparently is associated with high amounts of manganese. Saito[19] called asimilar disturbance of the bark necrosis Seki Sin Byo (赤疹病) in Japanese, and he stated that Seki Sin Byo had no relation with boron, In 1947, Thomas[23] showed that bark abnormalities resembling the Internal Bark Necrosis was not found to be associated with the concentration in the leaf of Aluminium, Iron, Boron and Manganese. In 1954, Shannon[20] conclude that manganese toxicity is more active than boron deficiency in inducing Internal Bark Necrosis. More recently, in the cause of more extensive studies Clulo and Berg[4] showed that Internal Bark Necrosis is manganese toxicity affecting apple trees. In attempting to find the cause for the disease the writers [16] in 1962 suggested excess manganese in plant is important factor in the development of the bark necrosis and the disease occures when susceptible trees take up manganese from soil in toxicic quantities.

Although manganese is one of those elements which is required in trace only for normal plant growth, it has a toxic effect on plant growth when plant has excess. Manganese toxicity have been described as early as 1909 by Kelly[17] in the poor growth of pineapple in Hawiian Islands. Since then many experiments of manganese toxicity were reported by workers.

Symptom

This disease is of importance on the variety of Rolls Jenet and Delicious growing in Korea, though it occurs occasionally on the other varieties. The disease appears on the bark of 1-or 2 year-old stems. In the early stages of the disease small elevation are visible on the epidermis. As the disease develops the bark becomes rough and scaly. The leaves of diseased trees, or affected branches may be small, and the leaves show a yellow discoloration and sometimes large or small yellow areas. On young trees having the disease the whole tree is dwarfed. Affected branches, or sometimes the whole tree may die. The most characteristic symptom is the presence of the necrotic areas in the outer bark. The necrotic areas are indicated by the brown as dark color of the inner bark. When the inner bark of diseased tree is exposed to air, it become discolored almost immediately, in contrast to that of healthy trees. The disease usually make its appearance in late summer and develops with great rapidity after the first symptoms become visible.

A. Leaf and soil sampling techniques:

Procedure

A. Leaf and soil sampling techniques:

During the period from July 30 to Octorber 16, 1963, leaf samples were collected from many apple producing areas in Korea, such as Taekue, Chungzue, Jesan, Suwon. Each sample is a composite consisting of the middle of current terminal shoot leaves selected at random different side of one tree. The tree were selected from both visible healthy and diseased Ralls Jenet which were approximately the same age, averging twenty years but there was some variation. The collected leaf was wiped with a wet cheesecloth (0.2%—acetic acid solution) to remove spray residue and dirt while they were fresh. The samples were dried to a constant weight at 70 degree C in a draft oven, ground to pass a 40 mesh sieve and stored in glass sample bottle perior to analysis.

Soil samples were taken from the soil (about 20 cm. depth) from which the leaf samples were collected. And the samples were air dried, screened through 20 mesh sieve and stored in glass sample bottle perior to analysis

B Analytical Procedure

Total Nitrogen was determined by the Kjeldahl methods[1]. Potassium was determined using a Bekman Model B Flame Photometer[7]. Calcium and Magnesium were determind by the E. D. T. A. titration.[8] Colorimetric determination for Phosphorus,[6] Iron and Manganese[18] were made with a Fisher Electrophotometer.

In procedure of extracting soil manganese, Sherman and McHarue[21] method were adapted. However, new soils were used in each forms; water soluble, exchangeable and reducible manganese, respectively.

Soil pH was measured by Bekman Model 76.[14]

Results, Discussion and Conclusion

As shown in table, 36 samples were collected for health, 39 samples for disease. The range of values for each nutrient-element among areas showed considerable variation. In all areas, diseased leaves were lower in nitrogen, phosphorus, potassium, calcium than healthy leaves, but there is no significant in "t" test between disease and health. Also diseased leaves had lower iron content than the healthy one. Manganese content of diseased leaves and soils is higher than healthy one. Soil had become quite acid.

Results obtained from chemical analysis indicated that the manganese content of diseased leaves was significantly higher than that of healthy leaves (1 per cent levels) and average manganese content of diseased leaves was 4.5 times as high as that of healthy leaves. And two soils from which leaf samples were

Table: The data presented show arithmetic means and standard errors of the means of nutrient elements and soil pH

Areas	Date of Sampling	Symptom	No of Sample	Leaf N	Leaf P	Leaf K	Leaf Ca	Leaf Mg	Leaf Fe	Leaf Mn	Soil water soluble Mn	Soil Exchangeable Mn	Soil Reducible MnO_2 as Mn	Soil pH
Yesan	1963.7.30	H	10	2.59±0.3	0.178±0.1	1.87±0.07	1.27±0.05	0.31±0.02	※※ 186±30	285±38	1.6±0.5	6.3±1.8	37.6±4.7	4.43±0.12
		D	10	2.48±0.4	0.181±0.1	1.83±0.07	1.27±0.07	0.31±0.02	※ 148±13	※※ 1012±90	2.6±0.9	8.0±2.3	※ 64.8±11.6	4.54±0.10
Chungzue	1963.8.7	H	9	2.63±0.4	0.175±0.1	2.01±0.03	1.32±0.05	0.35±0.03	152±12	336±58	2.0±0.76	4.3±2.1	41.9±8.1	4.73±0.16
		D	12	2.45±0.4	0.171±0.1	1.85±0.10	1.17±0.07	0.34±0.02	113±10	※※ 1369±91	※ 4.8±0.71	4.9±1.3	※※ 51.9±11.5	4.71±0.16
Taekue	1963.8.10	H	11	※※ 2.80±0.6	0.190±0.1	※ 2.05±0.05	1.34±0.03	0.31±0.01	116±10	273±20	5.1±0.1	9±0.15	511±3.6	4.85±0.19
		D	11	2.50±0.3	0.150±0.1	1.59±0.10	1.31±0.04	0.32±0.02	101±10	※※ 916±71	6.5±1.1	11±6.8	※ 46±16.5	3.95±0.08
Suwon	1963.8.16	H	6	2.49±0.4	0.173±0.1	1.77±0.10	1.47±0.10	0.032±0.01	※※ 238±21	150±61	0.9±0.3	1.1±0.2	43±0.3	4.42±0.13
		D	6	2.34±0.7	0.153±0.1	1.66±0.03	1.22±0.10	0.31±0.01	85±3	※※ 904±104	1.1±0.2	1.2±0.8	83±0.2	4.72±0.19
☆ Average	1963.7.30 8.16	H	36	2.63±0.12	0.179±0.02	1.93±0.012	1.35±0.025	0.32±0.009	173±15	261±23	2.4±0.5	5.2±1.0	33±4.4	4.61±0.11
		D	29	2.44±1.19	0.164±0.14	1.73±0.032	1.24±0.030	0.33±0.012	112±8	※※ 1050±63	3.8±0.7	6.2±1.5	※ 61±4.5	4.44±0.19

☆ Average values calculated from area averages. H…Health. D…disease

※, ※※ significant (Health v.s Disease) "t" Value at 5% and 1% levels respectivly.

collected had a significant diffierence in reduciable manganese. The disease is most prevalent on acid soils containing appreciable amounts of reducible manganese. While it was proved by the writers in 1963 that the application of $MnSO_4$ to the soil of healthy tree in Wagna Pot showed the same diseased symptoms. In 1951, Benson[5] mentioned that if a apple leaf possesses more than 500 ppm manganese it will show manganese toxicity.

Meanwhile, many workers[24] confirm that Fe/Mn ratio is important to assure optimal plant growth, and have established the ratio should be lie between 1.5 and 2.5 Somers and Shive[22] confirms that pathological symptoms produced with the manganese toxicity is identical with iron deficiency or vice versa. The Fe/Mn ratio for Ralls Jenet in Korea, except disease, is 0.663 in average. If this ratio is good for healthy trees, Somers and Shive's hypothesis of Fe/Mn ratio can't accept to the writer.

The other nutrient elements did not show any characteristic differences between healthy and diseased leaves.

Consequently those difference indicate that the disease must be manganese-toxicity and the manganese in soils is reducible form.

The various research workers reported[2][9][12][17] that the uptake of manganese by plant is influenced by the soil pH, Eh. Wet. Temp., Dry, Microbe, Light, Organic matter, Ion etc. In the field culture the availability of manganese is influenced more by soil reactions than any other factors and the availability decreases above pH 5.5[16] and ceased at pH 8.[11] Serious deficiency occurs at pH values of 6.5 to 7.5[16] Otherwise the availability is greatest in very acid soils[11] (below pH 4.5)

As shown in the table, the soil have become quite acid due to long and continued use of acid fertilizer such as ammonium sulfate and there is a greatest possibility of manganese toxicity.[13][16][25] But low soil pH values do not always indicate that the trees growing on those soil will not contain excess manganese in their tissues.

As mentioned above, the bark disease must be due to the manganese-high content in leaf. In order to prevent the disease, plant absorption of manganese must decreased with increasing soil pH, or by other means.[2][10] The soil pH can be controlled by appling lime, or other nutralizing substance.

Summary

Leaf analysis was used as a means of diagnosis of unknown apple bark disease. The results obtained from analysis may be summarized as follow;

Manganese is one of the most important element in the development of the bark disease. Evidence supporting this view was presented in 1962 by writers. Diseased symtom appears about 904 ppm of manganese and on average, manganese content of diseased leaves was 4 times as high as that of healty leaves. There is a significance between the reducible manganese in soil and the absorption of manganese in diseased leaves.

Consequently, the disease should be considered manganese toxicity and may be the same one described by Berg as "Internal Bark Necrosis." In order to prevent the bark disease, plant absorption of manganese must be decreased with increasing soil pH, or by other means.

Literature Cited

1. A.O.A.C. 9 th p 12 Washington 4 DC 1960.
2. 青木茂一 マンガンの諸問題 農業及園藝 **26**：425 ～428, 1951.
3. Berg. Anthony and Genevieve, Clulo, The Relation of manganese to Internal Bark necrosis of apple. Science **104**：265～266, 1946.
4. Berg, Anthony., Genevieve, Clulo and C.R. Orton. Internal Bark Necrosis of Apple Resulting from Manganese Toxicity. W. Va. Univ. Agr. Exp. Sta. Bul. 414 T. 1958.
5. Benson, N.R. and S.C Vandecaveye, Soil Fertility Conditions in the Apple Orchards of North Control Washington, Wash. Agr. Exp. Sta. Bul. 52 T 1951.
6. 植物榮養學實驗編輯委員會 植物榮養學實驗法(朝倉) p.28, 1959.
7. 〃 p.43, 〃
8. 〃 p.55, 〃
9. Fujimoto, Chas. K., and G. Donald. Sherman, The effect of Drying, Heatiing, and Wetting on the

level of Exchangeable Manganese in Hawaiian Soils. Proc. Soil Sci. Soc. Am. **10** : 107～112, 1945.

10. Fujimoto, Chas. K., and G. Donald. Sherman, Behavior of Manganese in the soil and the Manganes Cycle,Soil Sci. **66** : 131～145, 1948.

11. Gutschick, Research on the Manganese and Iron Cycles in the Forest, For. Abs. 8 (350) G. 1946.

12. 橋木重久 マンガン缺乏とその對策, 農業及園藝 **32** : 43～47, 1957.

13. 小林章 土壤反應力果樹の生育に及ぼす影響 農業及園藝 **33** : 1083～1084, 1958.

14. 京大農學部新改版 農藝化學實驗書(產業) p.248 1957.

15. Lee, C.J. and Y.D. Park, The Effect of High Manganese Content on Bark Necrosis Disease of Apple Trees, 論文集(高大農大) **1** : 247～256, 1963.

16. Lucas R.E. and J.F. Davis, Relationships Between pH values of organic soil and availabilities of 12 plant Nutrients Soil Sci. **92** : 108, 1961.

17. Mulder, E. G; and F. C; GERRETSEN. Soil manganese in relation to plant growth Advances in Agromomy Ⅳ : 221～277, 1952.

18. 農業技術協會 作物試驗法 p.352, 1960.

19. 齋藤泰治 リンゴ編(養賢堂) p.217～218, 1954.

20. Shannon, L. M; Internal Bark Necrosis of the Delicious apple. Am. Soc. Hort, Sci. Proc. **64** : 165～174, 1954.

21. Sherman, G. D; S. J; MCHARGUE and W. S. HODGKISS. Determination of Active Manganese in Soil, Soil Sci. **54** : 253～257, 1942.

22. Somer, I, I, and J.W. Shive. The iron-manganese relation in plant metabolism. Biological Abst. **17** : 22～24, 1944.

23. Thomas W.B. March; and F.N. Fagan, Foliar Diagnosis: Internal Bark Necrosis in Young Apple Trees, Am. Soc. Hort. Sci. Proc. **50** : 1～9, 1944.

24. Twyman, E.S. The Fe/Mn balance and its effect on the growth and development of plants. Biological Abst.**20** : 21065,1949.

25. William, D. Emerton; and James Vlamis. Manganese and Boron Toxicities in Standard Culture Solution, Proc. Soil Sci. Soc. Am. **21** : 205～209, 1957.

26. Yung, M. C. and H.F. Winter, Apple Tree Measles. Phylophthology **28** : 23, 1938.

摘　　要

近年 우리나라의 果樹生育을 害치는 Bark Necrosis의 原因을 究明하기 위한 葉 및 土壤分析의 結果는 다음과 같다.

망강은 本病誘因의 가장 重要한 因子의 하나이며 1962年 筆者에 依하여 얻어진 結果와 同一하다.

罹病狀은 葉中 Mn 904 ppm에서 發生하였으며 平均 罹病葉의 Mn 含量은 健全葉(外觀上)의 4倍이다.

以上 記述한 바와 같이 本 Bark necrosis는 Mn 過多吸收에서오는 Mn-toxicity이며 Berg가 말한 "Internal Bark necrosis"이다.

本 Bark necrosis를 防止하기 위하여서는 土壤 pH를 높이거나 혹은 다른 方法으로 果樹의 Mn 吸收를 減少 시켜야 한다.