Investigations on a Bergamot Gummosis in Calabria (Italy)

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The bergamot industry has been important for a long time in a restricted area of Calabria, in southern Italy, where about 3,850 hectares are planted. Many diseases affect bergamot (Terranova and Cutuli, 1975), but the most widespread is a disease of the branches and trunk called bergamot gummosis. The disease has been known for more than a century, but, in spite of many reports, the cause is still unknown (Magnano di San Lio *et al.*, 1978). This study was undertaken in 1975 to fill this gap.

SYMPTOMATOLOGY

The first symptom of the disease is the formation on the bark of moist spots and bumps which later develop into pustules or longitudinal cracks 0.5-2.0 cm long (fig. 1A and B). Abundant gum exudes from the lesions (fig. 2A) from spring to autumn and is dissolved by the winter rains. The wood of affected branches have one or more layers with gum pockets alternating with normal xylem layers.

In some cases, the leaves become small and yellow, and fall. Twigs die and, as the disease progresses downward, suckers may develop from the scion or the stock. When affected limbs are cut back, new stems develop, which show symptoms 2 or 3 years later.

Sour orange, which is the only rootstock used, is symptomless even when symptoms on the scion are severe. Fifteen 30-year-old trees with lemon or sweet orange interstocks show external symptoms only on the bergamot. Near Bova Marina, more than 1000 severely affected trees were regrafted to lemon 3 years ago and do not show gummosis as yet. In another location, eruptive gummosis and concentric rings of gum in the xylem have been observed on grapefruit and sweet orange limbs growing from bergamot trees affected by gummosis. In the same orchard, gum exudation like psorosis A was present on Tarocco sweet orange trees.

The disease affects the young xylem, producing schizolysigenous cavities filled with gumlike substance and lined by hypertrophic, roundish, cicatricial cells. These cavities are located mainly in xylem rich in large vessels and metatracheal parenchyma and, therefore, are assumed to originate during the summer. Phloem shows no alteration. Medullary rays appear modified by the pressure of the gum, but are not directly affected by the disease. The cambium remains functional and produces new layers of healthy phloem and xylem. Gum pockets are pushed inside the pith and coalesce, forming gum ducts. Gum originates from parenchymatous cells lining the cavities and from cell wall degeneration. Gum production continues in cavities formed in previous years, and accumulates as concentric rings inside the central cylinder (fig. 2B). When external xylem layers split, the gum exudes through the bark and a gummy cicatricial tissue repairs the lesions.

GEOGRAPHIC DISTRIBUTION AND DISEASE INCIDENCE

Bergamot gummosis is widely distributed in Reggio Calabria Province, along the Tyrrhenian coast and the southern part of the Ionian coast. The disease is more frequent in Gallico, Pellaro, Bova and Palizzi up to 50 km south of Reggio Calabria where it is present in every orchard and may affect up to 90 per cent of the trees. Moving east from Palizzi, the disease is less frequent and symptoms less severe; at Africo, they disappear. Symptoms have not been observed in about 100 hectares of bergamot orchards in Bianco, Ardore, S. Ilario, Locri, and Monasterace.

All varieties of bergamot (Femminello, Castagnaro, and Fantastica) are affected. Symptoms are more severe on trees over 10 years old. Young trees (3-4 years old) show only gum deposits in the xylem.

Gum production has been observed under different soil conditions. Trees which are well fertilized and cultivated show only slight symptoms of decline, even if bark lesions are present, whereas noncultivated trees appear chlorotic and decline rapidly. The disease may be associated with foot rot gummosis, mal secco, shell bark (Terranova and Cutuli, 1975) or with cristacortis and psorosis-like symptoms in the leaves and trunk. Attempts to isolate parasitic microorganisms revealed the presence of many different fungi, which are usually associated with bark diseases.

Dictyospermum scale (*Chrysomphalus dictyospermi* Morgan) is always present in the area affected by the disease, and in many cases, the trunk, limbs, and twigs of trees are covered, which may cause longitudinal bark splitting and gum exudation.

CHEMICAL ANALYSIS

Leaf and soil analyses have been conducted in affected and healthy groves to investigate the relationship to bergamot gummosis. The nitrogen content is 1.8-2.0 per cent in leaves from trees severely affected by the disease (showing chlorosis), whereas in healthy trees, it ranged from 2.2-2.4 per cent. The P, K, and Mg contents of healthy and affected trees were similar and did not differ from standard values. The Ca content was generally normal, but chlorotic leaves averaged less than 3.0 per cent.

Microelement content (Cu, B, Zn, Fe, Mn) in the wood and bark of affected and healthy trees did not differ. Soil pH, electrical conductivity, and chlorine and sodium ion concentrations in the saturation extract were in the normal range. However, the chlorine and sodium contents were frequently higher in the groves affected by gummosis.

INDEXING AND TRANSMISSION TESTS

In 1977, 2-year-old Femminello bergamot trees, growing in a field near Catania (Sicily), were inoculated with bark from twigs on affected branches. Two years later they showed no sign of gummosis. Bud propagations of affected trees on healthy rootstocks have shown no symptoms after two years.

Healthy bergamot budsticks were topworked on an Avana mandarin tree showing severe symptoms of concave gum, i.e. concavities on the trunk and limbs. Scions showed no symptoms of gumming after one year.

Affected and healthy trees have been greenhouse indexed on sour orange, Etrog citron 60-13 and Mexican lime. All of the trees indexed induced young leaf and oak-leaf symptoms on sour orange, and exocortis leaf curl on citron. Mexican lime showed only a psorosis-like symptom in the leaves.

Buds of Alemow, Orlando tangelo, and Etrog citron 60-13 grafted on limbs of 10 affected trees failed, because the buds were killed by gum reaction of the trees.

DISCUSSION

Because of its peculiar symptoms, distribution and incidence, bergamot gummosis resembles a virus disorder showing similarities with Rio Grande gummosis (Childs, 1978), psorosis A (Roistacher, 1975), and concave gum (Klotz, 1975). Indexing and propagation tests have been inconclusive to date. All three diseases are characterized by the formation of schizolysigenous cavities filled with gum in the young xylem. This is a nonspecific reaction of citrus to infectious agents and physiological disruptions (Schneider, 1973).

Certain features make it difficult to attribute bergamot gummosis to any of them. The necrosis and the wood discoloration present in the Rio Grande gummosis are lacking in bergamot gummosis. Moreover, gum is produced in the roots of trees affected by Rio Grande gummosis, whereas those of affected bergamot trees are normal.

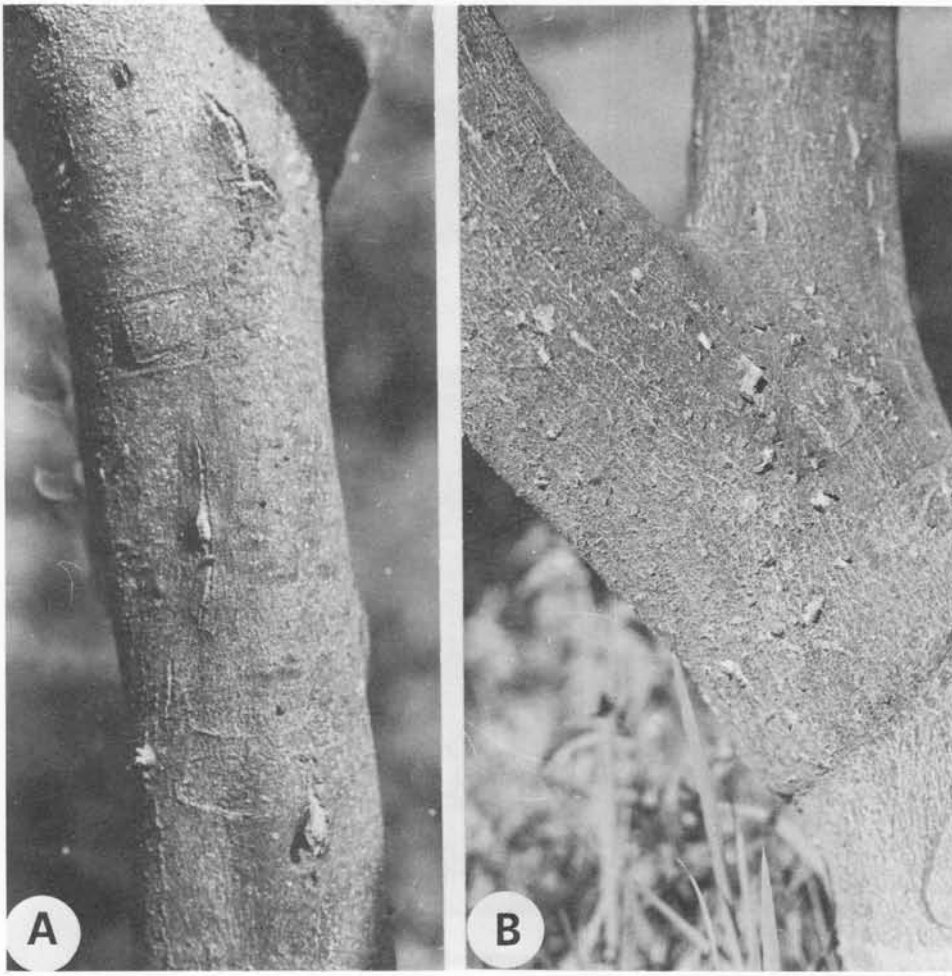

Fig. 1. Bergamot gummosis: A) bark lesions on the trunk. Cicatricial callus is visible between the lips of the pustules; B) scaling of the bark on an affected tree. Sour orange rootstock shows no symptom.

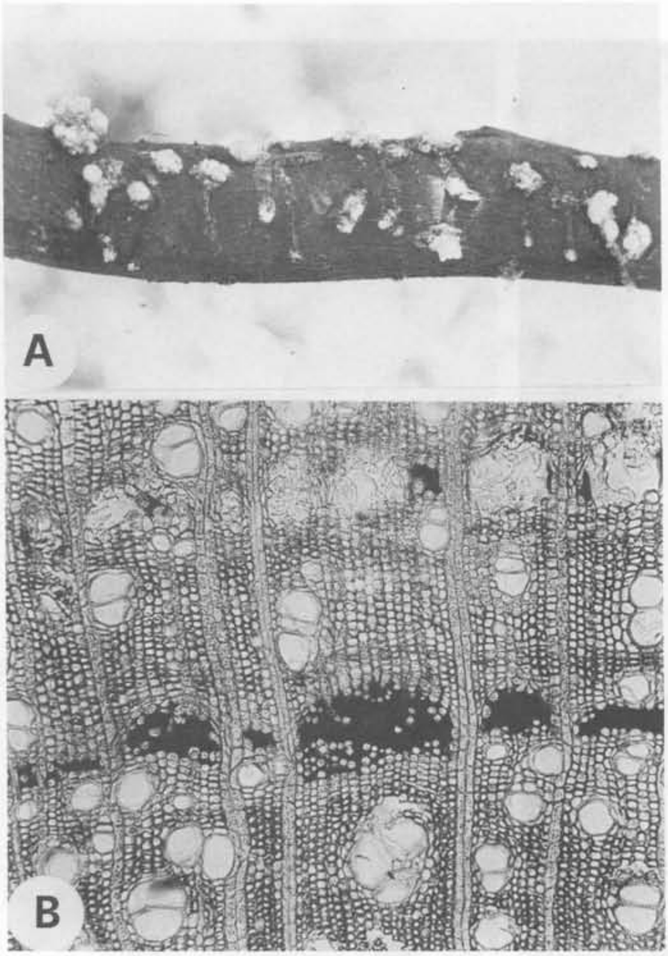

Fig. 2. Gum production in bergamot gummosis: A) abundant gum exudate on the limb in summertime; B) transverse section of a twig. Two rings of gum-pockets are visible in the xylem. Newly formed gum-pockets appear in recently differentiated xylem layers (top).

Psorosis A and bergamot gummosis are distinguished by the absence of phloem and bark modifications in the latter, which are important symptoms for diagnosis (Schneider, 1969). Furthermore, typical scaly bark is not always present on sweet orange interstocks.

Lastly, bergamot gummosis has been considered to be concave gum (Terranova and Cutuli, 1975) because of the similarities with the symptoms described in Corsica on Washington navel orange and Orlando tangelo (Vogel, 1974; Vogel and Bové, 1974, 1976). Even assuming that not all strains of concave gum virus induce the concavities described by Fawcett and Bitancourt (1943), some elements of our investigation do not allow that conclusion: 1) none of the many thousands of affected trees examined has shown concavities in the trunk or limbs; 2) the extraordinary incidence of the disease only in one area of bergamot cultivation, and the absolute absence of symptoms in other areas of cultivation although affected and healthy plants come from the same nurseries; 3) the lack of concavities on sweet orange and grapefruit interstocks.

For the above reasons, we suspect that other components, i.e. pedoclimatic factors, are directly or indirectly involved with the symptomatology of the disease. These conclusions are strengthened by the presence in the same area of a large number of Clementine trees, and some sweet orange trees with pustules, scaly bark and gumming on trunk and branches, symptoms which are not present in other citrus areas of Calabria.

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