

STUDIES ON THE CROWN GALL DISEASE  
IN A.R.E.

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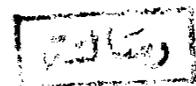
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## A C K N O W L E D G M E N T

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## I N T R O D U C T I O N

Crown gall disease of plants, caused by Agrobacterium tumefaciens ( Smith & Townsend ) Conn, has drawn the attention of number of investigators since 1907 when Smith & Townsend found that a bacterium was the cause of this kind of plant neoplasm.

The general symptoms of the disease in nature characterized by true gall found at the base of the stem of plant just below the ground level, on the part called the crown that the common name "crown gall" was suggested. These galls may be irregular globular with more or less convoluted surface, the size varying from that of a pea to gigantic overgrowths weighting 50 to 100 pounds, although this maximum size is rather uncommon. The surface of young gall is almost white at first, but later changes to the color of surrounding normal parts and may even become darker from the decay or weathering of the surface cells. Tumors formed on roots of herbaceous plants such tomato have been termed "soft crown galls" while those formed on woody plants such as peach called "hard crown galls".

The amount of injury caused by this disease varies with the

host, its age at the time of infection, location of the tumors and the type of host response. In various cases the following effects have been recorded : retarded growth and dwarf development, chlorotic foliage, the killing of branches and more rarely the death of the entire plant. In fruit trees the infections of young stock are more likely to cause injury than infections on older trees. In some cases nursery losses up to 70% have been recorded.

Various investigators agree that crown gall is a serious and destructive disease of almonds, peaches, plums, grapes , blackberries and raspberries, and is directly or indirectly responsible for the unprofitable condition of plants. In spite of the wide spread occurrence of crown gall disease of fruit and vegetable crops, the available reports on its occurrence on different plant hosts in ARE are rare. A survey of the literature has revealed the Agrobacterium tumefaciens attacks many plant species in ARE. The disease was recorded for the first time in Egypt by Melchers ( 1931 ) who observed the disease on Kaki ( Diopyrus sp. ) in ( 1924 ), on apple ( Malus sp. ) in 1928 and on Plum ( Prunus sp. ) in 1931. It is evident from the early reports in different nurseries for the production of peach, pear, plum, apple, almond and apricot that the disease increased gradually yearly till it

reached 22.5 and 1.3% for peach and pear in 1971. Moreover, the degree of infestation calculated for plum and almond in 1970 showed 10.0 and 33.7% occurrence respectively.

In this desertation some strains of the crown gall organism in the ARE were isolated and their pathogenicities were determined. Their morphological, cultural and physiological characteristics were investigated and their complete identification were carried out.

Variation in tomato varieties in their susceptibility to the disease was studied.

The host range of the isolated strains was determined. The effect of different manuring treatments of tomato on disease severity was investigated. For controlling the disease the effect of antibiotics on the growth of the organism and disease severity was also investigated. A trial was made to extract the growth promoting substances produced by the organism and to determine their effect on the growth of excised tomato roots.

## REVIEW OF LITERATURE

### Historical :

Throughout the past half century crown gall problem has been commonly regarded as the experimental model in the field of plant oncology.

The literature dealing with this disease is far more extensive than that of any other plant neoplasm. That the fundamental aspects of crown gall have been studied so intensively during the past 50 years is doubtless due in large part to the early and profound influence of a specific bacterium as the causal agent of this plant neoplasm appeared significant to pathologists generally.

Crown gall is important on apple, peach, apricot, almond, grape, pear, rose and cane fruits.

References to what was probably crown gall on roses and brambles can be found in horticultural writings between 1870 to 1890, but no definite scientific investigation of the disease was made until 1890. Attention was first called to the seriousness of the disease in California in 1892 by Wickson and Woodworth. At that time, it was recognized as a serious disease of nursery stock.

Setyan ( 1890 ) and ( 1900 ) a number of publications were issued calling attention to the seriousness of crown gall in nurseries and the danger of transmitting it to the orchards. Varying opinions were prevalent in the United States concerning the nature of crown gall. Some workers pointing to its probable infectious character, while others decided "that these root galls are not the work of a parasite, but are a malformation following some injury of the root or some uncongenial condition in soil or treatment" Bailey ( 1896 ). In Italy Cavara ( 1897 ) was the first to prove the bacterial nature of the disease on the grape, but his work as well as that of several other writers of southern Europe was either overlooked or discredited.

Toumey in ( 1900 ) demonstrated that the disease was infectious, but the causal organism was a new species of slime mold to which he gave the name of Dendrophagus globosus. Numerous other investigators worked with the disease in Europe and America without successfully isolating an inciting agency. Smith and Townsend ( 1904 ) however, isolated a bacterial pathogen from galls of the Paris daisy, Chrysanthemum frutescens, and were able to produce galls readily by inoculations with pure cultures and the organism was described in (1907). They gave the name of Bacterium tumefaciens to this organism which has since proved to be the cause of the various

hyperplastic responses characteristic of this disease on various hosts. Between 1903 and 1910 Hedgecock investigated the disease in the field using the extensive nurseries in the Mississippi Valley for his experiments and observations. He attempted to classify the galls according to whether they were "soft" or "hard" and divided the hairy root types into "simple", "woolly knot", "broom root", and "aerial". He studied the environmental conditions under which the galls occurred.

In ( 1923 ) series of investigations on crown gall started to accumulate as a result of a conference of nurserymen, entomologists, plant pathologists, horticulturists, and nursery inspectors.

Taylor & Philip ( 1925 ) observed the crown gall disease of the almond (*Amygdalus communis* ) in California which is very widespread and causes severe damage.

In England and Holland, crown gall was an important factor in only three or four places.

In Northwestern France no crown gall was observed; both the nurserymen and the nursery inspectors were familiar with the disease and occasionally reported it and in general it is never of any serious consequence ( Riker, 1923 ).

More recently Rodigin ( 1930 ) reported crown gall had

spread in the Lower Volga region and its importance as a disease of fruit trees was increasing. A survey showed that numerous apple trees were quite resistant where as others were very susceptible. Young pear, apricot and plum trees were also infected, 2 year old fruit trees were found infected more than 1 year. Lobik ( 1930 ) referred to crown gall of fruit plants in North Caucasus. Infections with Bacterium tumefaciens were found in Rostov, Bataisk, and especially apricot, apple, pear, plum trees, raspberry bushes and strawberry plants were affected.

In Mississippi Barker & Neal ( 1924 ) observed the disease especially in nurseries of apple and found that crown gall ( Bacterium tumefaciens ) affected primarily the Early Harvest, Early May, and Yates varieties causing up to 50% infection. In Ohio, Bart ( 1963 ) reported what appears to be the first occurrence of crown gall on Rhododendron.

Ark & Scott ( 1951 ) noted that crown gall ( Agrobacterium tumefaciens ) is of economic importance in almond, peach and walnut orchards in California. The incidence of the disease can be reduced by careful cultivation to avoid injuring the root system. A popular account is given for the general distribution, symptoms, causes, varieties attacked, and control of the so called "verruca" disease of the vine, which was stated to be the same disease as that known as rongra and maltia dei-

tuberculi in Italy as Krebs and Schott in Germany as broussing in France and as black knot, crown knot and can knot in the United States. In Argentine the disease is especially prevalent in Mendoza, San Juan and Catamarca.

Italian and American investigations have demonstrated that this disease is caused by the crown gall organism, Bacterium tumefaciens.

In Egypt El-Helaly, Abo-el-Dahab and Abo-el-Nil ( 1969 ) found the bacterium was newly recorded on rose, apricot, olive and pelargonium and also on Hibiscus sabdariffa, Zizyphus jujuba and Poinciana regia, all were not previously reported as hosts. According to their serological characters the 15 isolates from various spp. were divided into 2 groups, pathogenicity being similar within each group.

During the past twenty years extensive investigations have been directed toward basic studies on the crown gall organism in relation to cell proliferation and migration. In addition to the importance of these studies to the fruit disease problem they are interesting in that the organism concerned may be prove useful in solving some of the basic problems related to cancer in animals.

#### Crown gall and cancer :

Since the discovery of the bacterial etiology of crown

gall by Smith & Townsend ( 1907 ) this disease has been investigated by many investigators of pathological growth, partly no doubt because of the repeated assertions by Smith (1916) that crown gall of plants is a cancer.

Smith ( 1912 ) emphasized the resemblance of crown gall in plants to cancer in animals, he argued further that as cancer occurs in plants due to a parasite, cancer in animals must also be due to parasite.

The general description which Smith ( 1916 ) gave of the disease can be used of its various aspects, he stated "crown gall is a peculiar hyperplasia, the bacteria which are the cause of it developing sparingly and only within the cells, which they compel to divide early so that a great mass of non-capsulated, small cell tumor tissue arises in which the bacteria themselves are invisible. The tumors, even when deep seated are often incompletely vascularised, often quite fleshy and very subject to decay.

These conditions naturally result in the production of open wounds, which are subject to a variety of secondary infections, some of them very harmful to the plant. The tumor when inoculated on fleshy roots such as the sugar beet is often larger than the root itself".

Physiologically and structurally the tumor resembles cancer in many aspects. As in cancer, the nuclei of this tumor