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Use of Antibiotics in Plant Disease Control — A Review

by

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Introduction: Ever since Alexander Fleming reported on the bacteriostatic and bactericidal activity of *Penicillium notatum* in the year 1929, the study of antibiosis and antibiotic substances has advanced to a great extent and more than one hundred antibiotics have so far been isolated from various micro-organisms. Waksman (1947) clarified the confusion regarding the use of the word 'antibiotic' and defined it as, '*a chemical substance, produced by micro-organisms, which has the capacity to inhibit the growth of and even to destroy bacteria and other micro organisms*'. Most of the antibiotics isolated were tested for their use in medical science and a few of them like Penicillin, Streptomycin, Aureomycin and Terramycin have come into extensive use as chemotherapeutic agents. The use of antibiotic substances in agriculture, especially against plant diseases, is being worked out in different countries and some encouraging results have been reported.

Use against plant diseases: The possible uses of antibiotic substances in plant disease control, as understood at present, are briefly reviewed below:

(i) Control of soil-borne fungal pathogens is one of the serious problems confronting plant pathologists throughout the world and earlier workers have attempted to make use of the phenomenon of antibiosis in checking soil-borne diseases. As early as 1908 Potter stated that *Pseudomonas destructans*, the cause of rot of turnips, could be controlled by spraying a toxin produced by the bacterium in an artificial medium. Sanford and Broadfoot (1931) observed that the pathogenicity of *Ophiobolus graminis*, causing the "take-all" disease of wheat, could be checked by the culture filtrates of *Actinomyces* sp. and *Penicillium* sp. Tims (1931) obtained a certain amount of reduction in the infection of sugarcane by *Pythium arrhenomanes* when the soil was inoculated with some actinomycetes. Russian investigators (Chudiakov 1935, Novogrudsky 1936, Berezova 1939, Najmova 1939) have suggested 'bacterization' as a means of protection against plant pathogenic fungi. The susceptibility of the seedlings to infection was stated to be reduced

by treating the seeds with specific bacteria before sowing. Anwar (1949) was able to check the incidence of flax wilt caused by *Helminthosporium sativum* by adding metabolic products of certain soil micro-organisms. Unfortunately the studies made in recent years have shown that most of the antibiotics when added to the soil lose their activity for various reasons, thus making it unreliable to apply antibiotics to the soil for controlling plant pathogens. Intensive research is going on in leading laboratories of the world to overcome this defect and the recent publication of Wright (1952), stating that *Trichoderma viride* is capable of producing Gliotoxin in non-sterile but acid soil to which one per cent clover was added, is somewhat encouraging.

(ii) Solutions of antibiotics can be sprayed on plants as a preventive measure against air-borne diseases. Vander Laan (1947) found that Clavacin, an antibiotic produced by *Aspergillus clavatus*, could be sprayed on plants to prevent fungal infection. Felber and Hamner (1948) reported that the antibiotic Actidione, isolated from *Streptomyces griseus*, when sprayed on Red Kidney beans against *Erysiphe polygoni*, the mildew completely disappeared after 48 hours. Peterson and Cation (1950) and McClure (1952) could successfully eradicate *Coccomyces hiemalis* causing leaf spot of cherry by spraying Actidione. Gregory *et al* (1952) were able to control damping-off of alfalfa seedlings by spraying Actidione. Leben and Keitt (1952) found that Helixin, an antibiotic produced by *Streptomyces* sp., was effective in controlling early blight of tomato when sprayed at a concentration of 6·5 mgm./ml. Murneck (1952) found that spraying Thiolutin, an antibiotic from *Streptomyces albus*, reduced infection by *Erwinio carotovora*, the fire blight organism affecting fruit trees.

(iii) Antibiotics can be fed to plants through roots or through leaves so that they may act as systemic fungicides and prevent infection of the plants by fungi and bacteria. Repert and Hawas (1951) demonstrated the inhibitory action of Penitalin isolated from *Penicillium italicum*, on the development of galls in fruit trees due to *Bacterium tumefaciens*. Blanchard (1951) found that galls caused by *B. tumefaciens* on tomato plants were very few when the plants were grown in a solution of Aureomycin. Brian *et al* (1951) have demonstrated that Griseofulvin, an antibiotic obtained from *Penicillium nigrum*, acted as a systemic fungicide and prevented infection by *Botrytis cinerea* on lettuce and *Alternaria solani* on tomato. Brian (1952) reported that Gliotoxin, another

antibiotic obtained from *Trichoderma virede*, acted as a systemic fungicide in tomato plants and checked infection by *A. solani*. Gopalakrishnan and Jump (1952) found evidence for the systemic activity of Thiolutin in tomato plants against infection by *Fusarium oxysporum* var. *lycopersici*. The author in his studies with a new antibiotic produced by *Bacillus subtilis* found that it acted systemically in tomato plants when fed through roots and checked infection of the leaves by *A. solani*.

(iv) Internally and externally seed-borne diseases can be easily controlled by soaking the seed material in antibiotic solutions which can diffuse through the tissues and kill the pathogen. Timonin (1946) reported complete inhibition of germination of spores of *Ustilago tritici*, the fungus causing loose smut of wheat, in Patulin solution and claimed that diffusion of the antibiotic took place in wheat seeds. Wallen and Skolko (1950) found that internal infection of pea seeds, affected with *Ascochyta pisi* was effectively controlled by antibiotic XG, isolated from *Bacillus subtilis*.

(v) So far no satisfactory remedial method has been found out for the virus diseases of plants. In recent years some of the plant viruses are reported to be inhibited by antibiotic preparations and so with the advance of our knowledge and experience with antibiotics we may be able to control some of the serious virus diseases of plants. Ramon *et al* (1948) found that an antibiotic preparation obtained from *B. subtilis* exerted a marked neutralising action on tobacco necrosis virus. Gupta and Price (1952) have shown that the growth products of *Trichothecium roseum* exhibited an inhibitory action on plant viruses, which was demonstrated to be due to change in the host susceptibility rather than action *in vitro*. Leben and Fulton (1952) reported that the antibiotic Streptomycin inactivated tobacco necrosis virus *in vitro* and Terramycin prevented multiplication of tobacco mosaic virus. Stassel *et al* (1953) found that Toximycin, obtained from *B. subtilis*, inactivated tobacco mosaic virus *in vitro*. The author in his studies also found that, infection by the viruses of *Petunia* mosaic, Chilli mosaic and *Vinca rosea* mosaic was inhibited by an antibiotic isolated from *B. subtilis*. The inhibition was found to be due to direct action of the antibiotic on the virus *in vitro* rather than any change brought about on the host tissue. These results clearly show that by using antibiotics as systemic agents or as preventive sprays, the infection of the plants by viruses can be prevented.

(vi) Some of the antibiotics like Terramycin are reported to induce growth in plants and animals. Such antibiotics can be made use of in inducing more vigour in plants to withstand or escape the disease.

Discussion: Thus there is sufficient evidence to show that antibiotics can be widely used in plant disease control. There seems to be however, some shortcomings in putting them into practical use: (a) Some of the antibiotics are reported to be toxic to plants and in some cases they are known to affect the germinability of seeds, (b) most of the antibiotics lose their activity when added to the soil and in other cases they are thermolabile thus making it difficult to use them in agriculture, (c) in the case of the antibiotics which act systemically in plants, there is evidence of their activity being reduced or lost after a short period which creates additional trouble in putting them into use.

These shortcomings do not detract from the potentiality of these agents for controlling plant diseases. If anything, similar toxicity and other defects observed in putting them into use in human beings have led in the past to more intensive searches for better antibiotics. Besides these, the high cost of antibiotics makes one feel that it is impossible to use them in agriculture. It has been pointed out that the cost of penicillin, which was so high a few years back, has been brought down to such a low level that at present it costs less than that of the container in which it is packed. So it is hoped that with the quick advancement of science and our knowledge in antibiotics, these defects will be easily overcome and it won't be long before these substances come into extensive use in controlling plant diseases.

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