Benefits of Glucosinolates in Broccoli

Broccoli plant tissues contain glucosinolate compounds that may have beneficial properties for plants and humans.

Glucosinolates break down into isothiocyanates, which may contribute to the suppression of plant pests and pathogens.

Other factors associated with broccoli soil amendments may have additional effects to those of glucosinolates in the development of disease suppressive soils.

Growers have relied on broccoli and other brassica crops in crop rotations to help manage soil health and reduce disease pressure. These crops contain compounds called glucosinolates that may play a role in disease suppression.

What Are Glucosinolates?

Glucosinolates are sulfur-containing compounds found naturally in Brassica species, such as broccoli and cabbage. When broken down by the enzyme myrosinase, also present in Brassica plants, glucosinolates are converted into other compounds including isothiocyanates (ITCs). ITCs have been found to protect plants against some diseases and pests and to be useful in biofumigation when Brassica plants are incorporated into the soil as green manures.

Over 130 different glucosinolate compounds have been characterized. Different compounds are produced by different Brassica species, and various glucosinolates can be found in different tissues (roots vs. leaves) in the same plant. Glucosinolate compounds commonly found in broccoli include sinigrin, glucoraphanin, and gluconapin, with the highest levels typically found in broccoli leaves, flower buds, seeds, and sprouts. The level of glucosinolates produced in broccoli tissue is affected by soil and weather conditions, as well as levels of fertilization, methods of cultivation, and the cropping season (spring vs. fall).

Glucosinolates and their ITC derivatives have become a focus of research because of their role in plant defense, their effects on soil health, and the potential health benefits for people who consume Brassica vegetables such as broccoli. A study on the effects of glucosinolates produced by several Brassica crops on two bacterial pathogens and two fungal pathogens found that glucosinolate derivatives inhibited the growth of the pathogens in culture and that the level of inhibition depended on the amount of the compound tested. This study also showed that the different pathogens responded differently to the specific compounds, showing that the ability of a plant to suppress a pathogen depends on the compounds present in the plant and the particular strains of the pathogen involved.

Soil Health

In addition to being a factor in the disease resistance properties of a plant, glucosinolates and ITCs may be useful for pest management by affecting pathogens and pests in the soil. Biofumigation is the process in which the residue of certain Brassica species, such as broccoli, are incorporated into the soil for purposes of suppressing bacteria, fungi, nematodes, and weeds. This suppression is thought to be due, in part, to the release of ITCs from the macerated and decomposing tissue.

Laboratory studies have consistently shown the toxic effects of ITCs on plant pathogens growing in culture, but extrapolating from lab studies to determining the effectiveness in the field can be challenging. The amount of ITCs released depends on more than just the level of glucosinolates present in the plant residue. The conversion of glucosinolates to ITCs depends on the amount of myrosinase present in the plant residue and environmental factors, such as soil temperature, moisture, and other soil conditions. Therefore, the effectiveness of...
biofumigation with *Brassica* species, such as broccoli, to suppress soilborne pathogens can be greatly influenced by methods of crop destruction and incorporation and various soil environmental factors. A field study published in 1999 found that incorporating broccoli residue into the soil effectively suppressed the levels of Verticillium wilt in following broccoli and cauliflower plantings (Figure 1). A follow-up study found that rotating winter broccoli crops with summer strawberry crops in California reduced the level of the pathogen *Verticillium dahliae* in the soil, lowered the severity of Verticillium wilt on strawberry, and increased growth of the strawberry plants and fruit yield, when compared with rotations not including *Brassica* crops.

Other studies have shown that soil amendments with *Brassica* crop residues can inhibit a range of plant pests including bacterial pathogens such as *Ralstonia solanacearum*, *Pseudomonas marginalis*, and *Streptomyces scabies*, nematodes including root-knot nematodes and potato cyst nematodes, and fungal and fungal-like pathogens such as *Sclerotinia minor*, *Sclerotinia sclerotiorum*, *Verticillium dahliae*, *Rhizoctonia solani*, *Aphanomyces euteiches*, and *Pythium ultimum*.

Applications of mustard crops residues as mulch were shown to reduce disease levels of lettuce drop, caused by the fungus *Sclerotinia minor*, and to increase lettuce yields. Lettuce plants also produced larger heads in plots treated with the mustard variety ‘Ida Gold’, which produces high levels of glucosinolates. Other studies looking at the effects of cover crops and green manures on lettuce drop have found little to no disease suppression associated with *Brassica* treatments. The effects of *Brassica* biofumigation and the role of glucosinolates in the suppression of soilborne diseases are still unclear and topics of continuing study.

Compounds other than glucosinolates found in broccoli and other *Brassica* crops also appear to be involved in pathogen suppression. The addition of broccoli residue to soil was found to stimulate the naturally occurring community of biocontrol organisms in the soil, and the activity of these antagonists also suppressed soilborne pathogens. Other *Brassica* crops, including canola, rapeseed, radish, turnip, yellow mustard, and Indian mustard have been studied for their effects on soil disease suppression. The advantage of using broccoli as a green manure is that it is also a valuable horticultural crop that provides farm revenue, and broccoli fits well in rotation schedules with other vegetable crops.

**BRASSICA SPECIES IN BROCCOLI AND HUMAN HEALTH**

The consumption of broccoli, cabbage, and other *Brassica* vegetables has long been considered to contribute to a healthy diet, and studies have found that those benefits may result from glucosinolates and isothiocyanates. The results from a group of studies looking at the health benefits of eating *Brassica* vegetables showed an association of eating more *Brassica* vegetables with reductions in risks of several types of cancer and a reduced risk of myocardial infarction (heart attack).

Broccoli varieties with enhanced levels of glucosinolates have been developed, primarily for their potential human health benefits. These varieties may also be useful in managing soilborne plant pathogens and the diseases they cause.

**Sources:**


*Please note that any consumer product labels that bear broccoli-related health or nutrient content claims would need to be in compliance with FDA regulations applicable to such claims.*

For additional agronomic information, please contact your local seed representative. Developed in partnership with Technology Development & Agronomy by Monsanto.

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