After eight years of working with ChitosanHC, we give you, in this note, our experience and the results obtained from a large number of various applications.

1. In general.

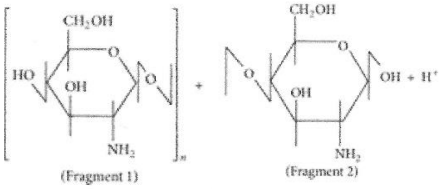
ChitosanHC has been used by us in very different areas such as golf greens, apple trees, cultivation of young fruit trees, clover for fodder, various vegetables, organic hop, organic grape, blue berries, roses hyacinths and lilies, ornamental plants .... The dosage ranged from 50 to 100 grams/Ha and the frequency of application from 7 to 15 days during growth, or 5 to 6 times per season depending on the crop.

In all cases, positive effects *were observed: increased vigor of plants, better appearance of leaves, measurable increase in stem and* leaf thickness with increased resistance to transpiration*(-25%) and frost (up to -2°C), a continuous growth gradient even during very hot periods (e.g. during the summer of 2017 and 2018), normal growth in soils infested with pathogenic nematodes,* ***good results again several fungal- and bacterial-diseases****. Leaf analyses show that more nutrients are found in the leaves of Plants treated with ChitosanHC (e.g. Ca, Fe and other cations). In soils too, there is* an increase in the proportion of *symbiotic organisms and biodiversity and* ***finally, a decrease in the need for pesticide use by -50% to -100%.***

No negative effects were observed, even in the production of fruits, flowers and vegetables.

For golf courses, the use was followed 3 years in a row; in other cases, it was tested in one/two seasons.

The product used is a chitosan chloride, totally soluble in water, with a degree of d acetylation (DDA) of 90% and a molecular weight of 10 kDa.(nano molecule) The chemical formula can be written



The molecule is composed of nitrogen, carbon, hydrogen and oxygen. Chlorine is calcined at the end of manufacture. The proportion of nitrogen is about 16% of which 70% is mineralized and therefore directly usable by plants. (Which is not the case for organically produced chitosan!)

The product is classified as a basic substance EU 563/2014 and is listed as a product usable in organic farming. (FIBL and EC 889/2008) .

2. Classification of the effects of ChitosanHC

The effects of ChitosanHC are manifested both by the leaves, directly, and by the soil, by the action of bacteria. When spraying, there is no loss of product, which is remarkable.

In the first case, the product systematically penetrates through the leaves, accesses each cell and causes *the formation of an enzyme* (chitinase) as well as the formation of hormones and proteins, all of which stimulate the natural defense system of *plants. It also forms* an increase in the thickness of cell walls that causes better resistance to *abiotic stress.* This case mainly applies only to plants with a lot of leaves as well as in combination with the following case.

In the second case, the product enters the soil and given its quality of "sugar" (polysaccharide) feeds many bacteria (for example, Bacillus, Pseudomonas, Actinomycete, Mycorrhizal fungi, Rhizobacteria,...).
ChitosanHC molecules are transformed by bacteria as a result of an enzymatic reaction so that the constituent *nitrogen (70% directly assimilable), carbon, oxygen and hydrogen are released slowly into* the soil. *ChitosanHC behaves like a fertilizer slowly releasing its components at the rate of its decomposition.*
The enzymes produced that come into contact with the roots are absorbed by the plant and *strengthen its biotic and abiotic defense system.*
These bacteria, fed by chitosanHC and other natural elements, proliferate and *the proportion of symbiotic organisms greatly increases* as well as the biodiversity and vigor of plants.
The part of chitosanHC not used by bacteria complex cations such as Ca, Fe, Zn, ..., *mobilizes them and facilitates their transfer,* directly or through mycorrhizal fungi, to the roots. The product has an "accelerator" effect that improves the availability of nutrients to plants as well as the transport of these elements in plants. This Chitosan also reacts in the plant as in the first case and forms stimulating and protective enzymes.

In fact, the described process occurs naturally in *historically good* biological quality *soils in which dead chitin-containing organisms are disintegrated by* bacteria and transformed into *chitosan, chitinase and other elements.*
(Natural Chitin Cycle)
The scientific literature mentions many other properties of chitosanHC; see, for example, "The multifunctional role of chitosan in horticultural crops; In Review. By Rahat Sharif, and others. (2018-02-27) »

3. Conditions of effective use of ChitosanHC: results.

In the case of golf greens, given the regular cut and the very short length of the leaves, the action via the leaves is almost not possible and *the action of ChitosanHC is almost 100% via the ground!*
In addition, all operations that improve the quality of the soil allow the beneficial action of ChitosanHC: the physical characteristics (permeability, structure, ...) and chemical (pH, minerals, balances, ...) of the soil must be sufficient and maintained on the

basis of tests and analyzes. The "top dressing" combined with vertical ventilation or other is very important!
The presence of bacteria (see list in point 2) is essential for the beneficial action of ChitosanHC. The use of bacteria-destroying chemicals is an obstacle to its effectiveness.
Also note *that the pH of the water used to dissolve ChitosanHC should be less than 6!* If the water is not acidic enough, you need to lower the pH with, for example, citric acid or another. Do not mix with products that increase the pH! (At pH above 6.3 ChitosanHC loses its poly-cationic character than as well as a large part of its responsiveness). When using chitosan with a wetting product, care must be taken to ensure that it is cationic and non-anionic and that it respects the organic life of the soil.
The usual dose is 100 g/Ha and the frequency every 15 days during the growing season and every 30 days in winter.
Note that the goal is first of all to feed the bacteria that, as a result of this action, release the elements that have a beneficial effect on plants!
Given the low doses used, *applications should be made very regularly.* In regions or during periods of high pathogenic activity, *the frequency,* not the *dose,* should first be increased. (For example, every week for a month). (For very local use a dosage of 0.5 gr/liter is used).
ChitosanHC also has a slightly healing effect, so it is advisable to spray after mowing if possible.
Finally, note that all ChitosanHC users who have applied the product regularly no longer use fungicide products from the third year of application.

In summary, the following parameters must, as a <u>priority, be</u> taken into account in order to have a beneficial action of ChitosanHC, (without forgetting the others):

- **pH of solution and mixture of less than 6,**
- **Use with an organic and cationic wetting agent,**
- **The porosity of the soil is ensured, on the surface and at depth of the roots,**
- **Presence of beneficial bacteria in the soil,**
- **The regularity of the applications.**