DISEASE CONTROL WITH QUALITY COMPOST IN POT AND FIELD TRIALS.

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Introduction

Different motivations can be observed with compost producers. While waste management is the principal goal of some producers, others produce compost in order to improve fertility of the soil and growth of the plants. These different points of view may influence compost management, and thus the quality of the final product. To ensure long-term sales, composts should be of high (micro-)biological quality, without harm to the environment and should enhance plant vigor and health. Today, vegetable growers increasingly require that composts not only have no negative influence on plant growth, but also improve plant health and reduce disease.

Compost influences plant growth and health indirectly via the growing conditions (by providing nutrients, especially micro nutrients and by improving soil conditions and water retention capacity). Composts are not inert materials; they are carriers of living organisms. If the fermentation is correctly managed, pathogens are killed during the heat period [1, 3]. At the same time, antagonists develop during maturation of the compost. Therefore, composts can reduce the incidence of various plant diseases [4, 6, 8]. If we also consider the positive effect of quality compost on soil structure, soil erosion and water capacity, it is obvious that an efficient compost management could increase and maintain soil fertility.

Not all composts are equal

Not all composts have the same capacity to protect plants against diseases. Whereas some composts for example did not protect cress against *Pythium ultimum*, other composts almost fully suppressed this disease (fig. 1). Loss of the suppressive effect of compost after heat treatment (one day at 90°C, fig. 1) indicates that disease suppression might be linked with the microbiological activity of the compost, although physiochemical and biological properties of composts could also influence suppression capacity [2].

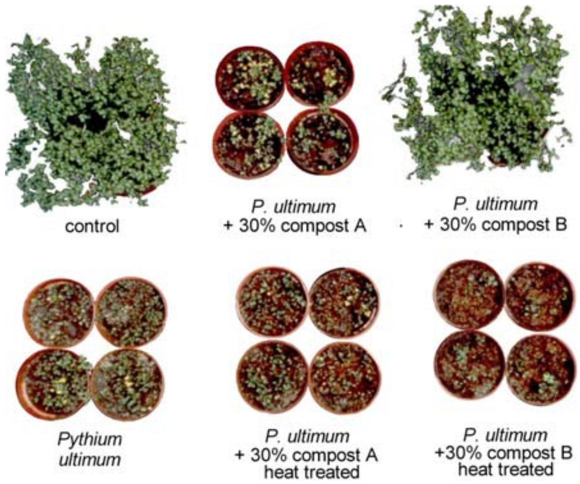

Fig. 1. Potential of two composts to protect cress against *Pythium ultimum* in comparison with untreated and heat treated (one day at 90°C). The two composts come from the same industrial composting plant.

Different diseases react differently to compost. While almost all composts tested protect cucumber plants against *Pythium ultimum* (fig. 2), only some of them have the capacity to protect basilic against *Rhizoctonia solani* (fig. 3). We assume a general protection mechanism for *Pythium ultimum* and a specific mechanism in the case of *Rhizoctonia solani* [8].

Influence of compost quality on its beneficial effects

In our observations, we found some factors correlated with disease suppressiveness. Amongst others, the composition and the maturity of composts influence the potential for plant disease suppression, and our experiments (data not presented here) confirm the results of Tuitert et al. [9]. In addition, the management of the composting processes, in particular the oxygen supply, seems to be the most important factor affecting compost quality. This is also of major importance in compost storage (data not published). Compost quality is not stable, if it is stored the wrong way; compost is living, and it can also die! AGood quality compost can become toxic for the plant in few weeks, if it is not treated correctly, for example if its aeration is too poor. So, compost quality is the result of careful management throughout the production chain, from collection of the raw material to storage and application of the final product.

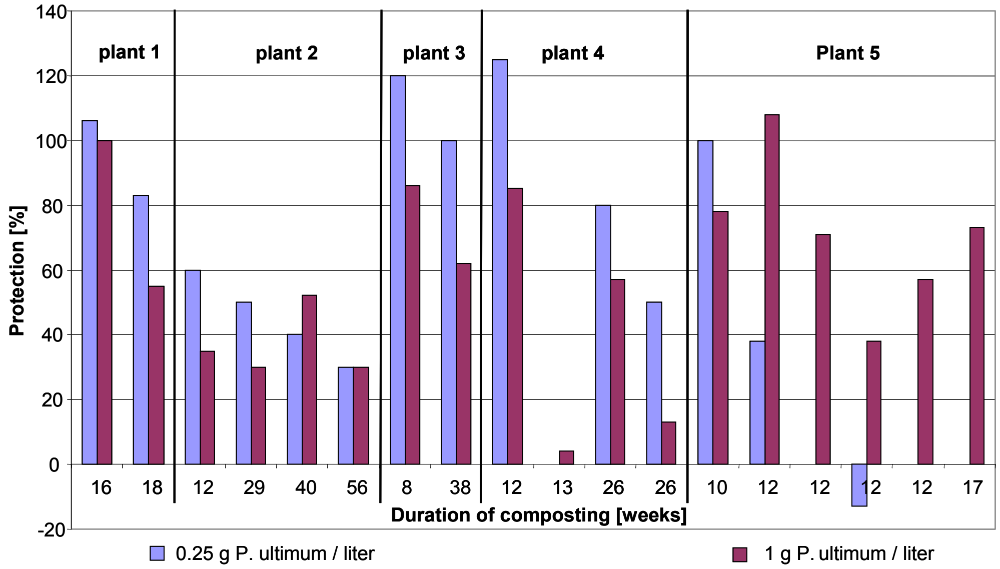

Fig. 2. Capacity of different composts to protect cucumber against *Pythium ultimum*. Plant survival was assessed 2 weeks after sowing. *Pythium ultimum* inoculum: 7 days old culture on autoclaved sorghum grains.

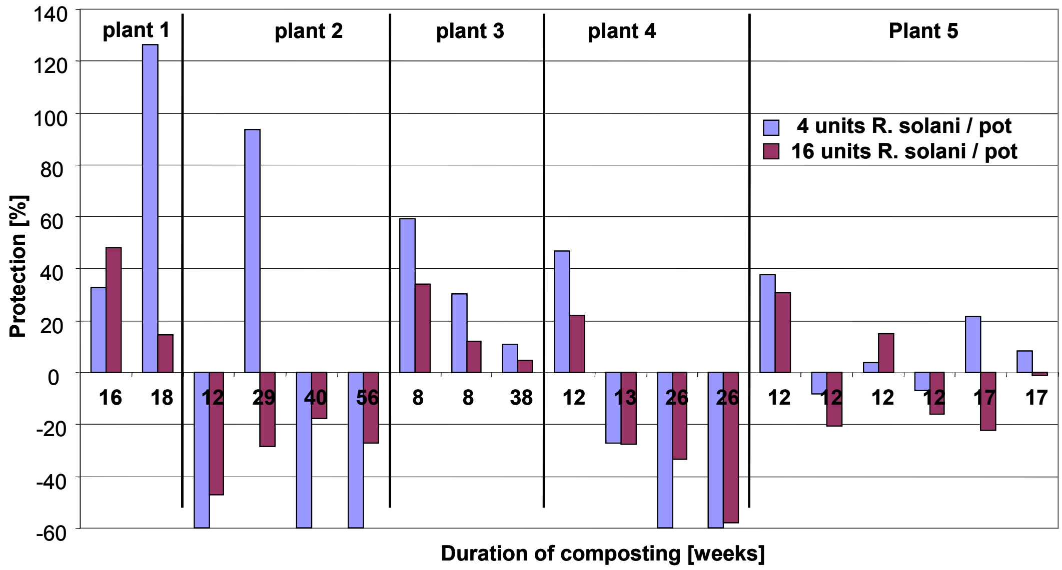

Fig. 3. Capacity of different composts to protect basilic against *Rhizoctonia solani*. Protection: reduction of plants dying, assessed 3 weeks after sowing. *Rhizoctonia solani* inoculum: 14 days old culture on autoclaved sorghum grains.

Quality compost as plant protection agent in practice

The capacity of quality compost to protect plants against diseases is not a scientific curiosity, but can have a great significance in practice, where it can solve serious phytopathological problems.

Compost for safe sprout production

Sprouts are produced on a thin layer of peat substrate, and after sprouting packed in cardboard boxes with cellophane film windows, in which they have to maintain their freshness for some days in the shop (fig. 4). The high humidity in the package is very favourable for the growth of mould fungi, which develop easily and quickly in such an environment, where the microbiologically inert peat cannot suppress mould growth. Infected sprouts have to be discarded, causing important losses. Adding quality compost (30% volume of substrate volume) solved this problem very efficiently. The compost microorganisms stabilised the environment surrounding the sprouts and prevented development of moulds.

Fig. 4. The living conditions of sprouts are highly favourable for mould invasion, if pure peat substrate is used. By adding 30 % of quality compost to the peat, the system can be microbiologically stabilised, and mould growth is suppressed.treated (one day at 90°C). The two composts come from the same industrial compost plant.

Quality compost in organic culture substrate

Industrially used peat substrates are microbiologically inactive. There, a very small quantity of pathogen inoculums is sufficient to get a high disease incidence (fig. 5). In these cases, adding quality compost can efficiently protect plant (fig. 3). The addition of compost stabilizes the substrate microbiologically, thus reducing the establishment of pathogens.

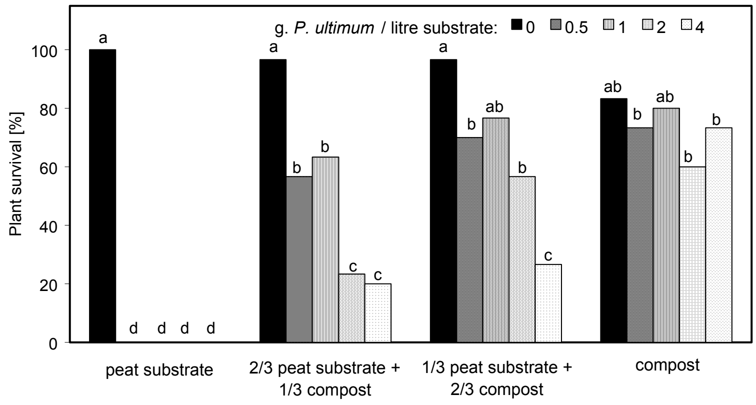

Fig. 5. Influence of compost on the incidence of cucumber damping off, causal agent *Pythium ultimum*, in peat substrate. Plant survival was assessed 2 weeks after sowing. *Pythium ultimum* inoculum: 7 days old culture on autoclaved sorghum grains. Mean of three independent experiments with 6 pots per replicate and 4 cucumber seeds per pot. Columns with the same letter do not differ significantly at P=0.05 (Multiple t-test), comparing each mean with each other mean considers one experiment as a replicate.

Quality compost for integrated soil steaming

Soil steaming is a very efficient and radical measure to eliminate soil borne plant pathogens, micro-organisms and weed seeds. It is used frequently in vegetable production in the field and the greenhouse. Because of its non-selectivity, it destroys the whole complex of flora and fauna in the soil, irrespective whether organisms are beneficial or harmful. Since soils are “biologically empty” after steaming, they are very susceptible to microbial colonization. Problematic is also the buildup of phytotoxic compounds in the soil, for example nitrite, because of degradation of dead biomass after the soil treatment.

Soil from a vegetable field was steamed for 6 hours at 100°C. When compost with controlled high biological activity was added to the steamed soil during the cooling process (when its temperature reached 40°C), the activity of the compost microorganisms drastically reduced the problems caused by steaming. Already a few hours after steaming, the nitrite level in the soil was stabilized (Fig. 6). Tomato seedlings which were transplanted into the activated soil one day after steaming developed vigorously and without any symptoms of phytotoxicity (Fig. 7a). Even the very sensitive lamb's lettuce, sown 24 hours after steaming, grew healthy and vigorously (Fig. 7b).

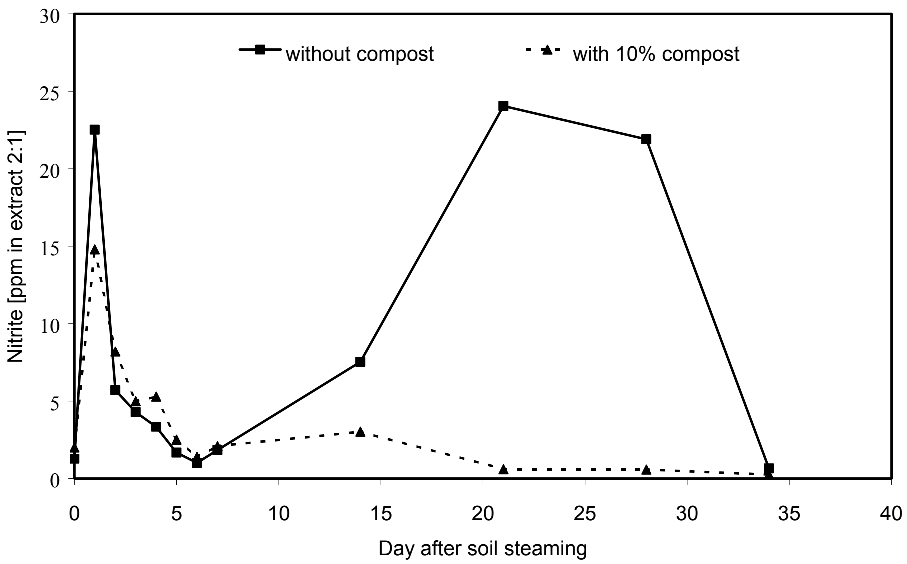

Fig. 6. Influence of compost on the development of the nitrite level in the soil after steaming. Compost was added to the soil after steaming. Each value is the mean of three independent experiments.

Disease incidence on cucumber sown in steamed soil without compost was high even with small inoculum quantities of *Pythium ultimum*. However, the addition of 10% of compost significantly reduced plant death. Five to ten times more inoculum would have been necessary to obtain approximatively the same disease incidence in the soil with compost as in the soil without compost (Fig. 8).

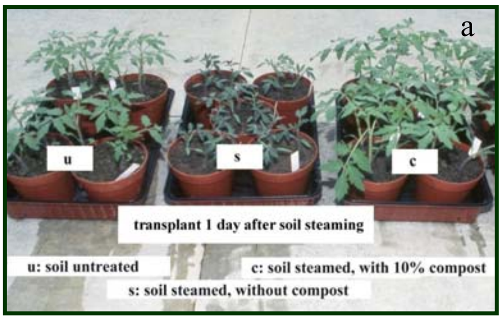

Fig. 7. Influence of compost on the phytotoxicity of tomato seedlings (a) and of lamb's lettuce (b)..

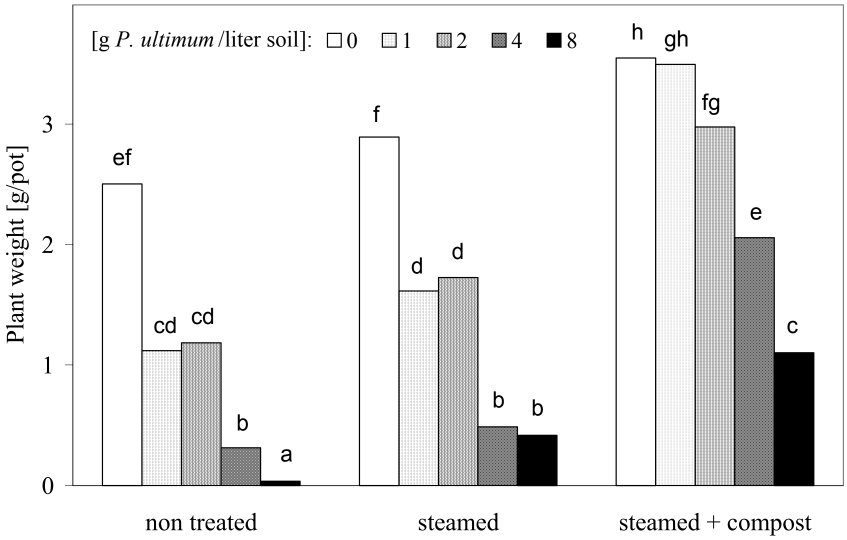

Fig. 8. Influence of compost on the receptivity to *Pythium ultimum* causing damping off on cucumber in the steamed soil. Compost was added to the soil after steaming. Each value is the mean of three independent experiments with six pots and four cucumber seed per pot. Columns with the same letter do not differ significantly at P=0.05 (Multiple t-test), comparing each mean with each other mean considers one experiment as a replicate.

Quality compost for improvement of soil fertility in the field

For the assessment of long term effects of compost on plant disease, fields were divided into two plots. On one half of the field compost was applied each year (10 tons dry weight per ha), while the other half was used as check. After five years, soil samples were taken on the different field plots. The disease receptivity of the soils for *Pythium ultimum* was lower in the plots with compost compared to those without compost (fig. 9). The same effect was also found for *Rhizoctonia solani*. Suppressive effects of compost could still be clearly observed one year after compost application We also found a negative correlation between more intensive soil cultivation and disease receptivity (data not shown). This is no surprise: the biological equilibrium is more disturbed in intensively worked fields, and therefore the positive influence of compost became more distinct.

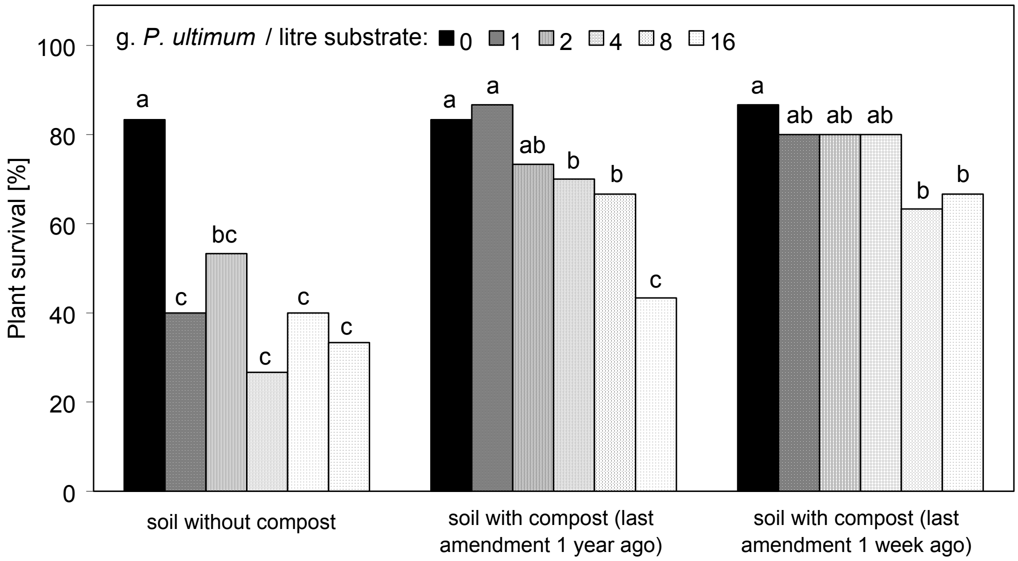

Fig. 9. Influence of quality compost amendments on the receptivity of soil to *Pythium ultimum*, pathogenic agent of cucumber damping off. Twenty tons of compost were given each year to one half of a vegetable field in Fehraltorf (CH), on the other half of the field no compost was applied. Soil samples were taken after five years before and after amendment with new compost. Plant survival was assessed 2 weeks after sowing. *Pythium ultimum* inoculum in laboratory tests: 7 days old culture on autoclaved sorghum grains. Each value is the mean of three independent experiments with 6 pots with 4 cucumber seeds per pot. Columns with the same letter do not differ significantly at P=0.05 (Multiple t-test), comparing each mean with each other mean considers one experiment as a repetition.

Quality compost and induced resistance

The effects of quality composts added to soil are not restricted to suppression of soil borne disease. They also reduce the development of foliar pathogens such as *Blumeria* (*Erysiphe*) *graminis* f.sp. *hordei*, the causal agent of barley powdery mildew (fig. 10). The potential to induce disease resistance in barley plants, varied considerably from compost to compost, depending on their biological quality (fig. 10). No correlation between nitrogen content or nitrogen availability of the composts and pathogen suppression was found.

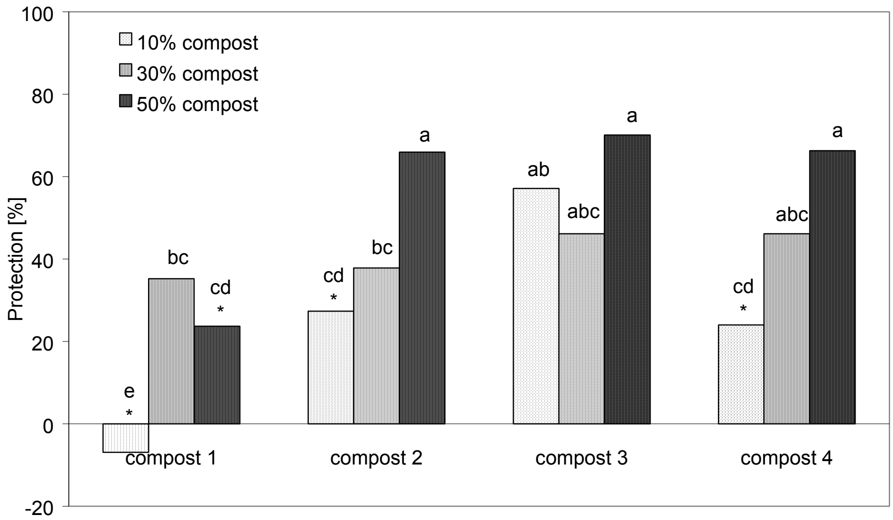

Fig. 10. Influence of composts on the incidence of the barley powdery mildew, caused by *Blumeria graminis* f.sp. *hordei*. Composts from different batches were added to the substrates (Brill No. 5, Gebr. BRILL, D-Georgsdorf) before sowing (10, 30 or 50% of substrate volume). After ten days, the first leaves of barley were inoculated with *B. graminis* conidia. Protection: reduction on the colony units formed on the leaves one week after inoculation. Each value is the mean of three independent experiments with 4 pots with 10 barley plants per pot. Columns with the same letter do not differ significantly at P=0.05 (Multiple t-test), comparing each mean with each other mean considers one experiment as a repetition. Columns with a * do not differ significantly at P=0.05 compared to the check

Quality insurance: the key to success

Although not all mechanisms and factors that influence biological compost quality are known as yet, our knowledge is broad enough to allow the production of good quality compost. The three most important factors to control during fermentation are the moisture of the material, the air composition and temperature. At the end of maturation, the following quality parameters have to be analyzed: pH, salt content, ammonium, nitrite and nitrate content. In addition, we propose to carry out plant tests [5] for two reasons: (i) plants react to compost quality as a whole, and so hidden problems can appear; (ii) plants react during the entire test period (about two weeks), thus the evolution of some parameters can be observed. This is particularly important for nitrogen availability. For composts used in horticultural and vegetables production, testing their disease suppressive potential with the *Rhizoctonia* and *Pythium* tests is recommended. With this information, it is possible to choose the most appropriate compost for each utilization. The ASCP Guidelines 2001 “Quality criteria for composts and digestates from biodegradable waste management” (published by the Association of Swiss Compost Plants (ASCP) in collaboration with the Swiss Biogas Forum) provides support for compost producers and compost users in this respect [7].

Conclusions

Quality compost can have a positive effect on soil fertility and plant growth and health. This positive effect is not only observable in the laboratory, but also by growers. Phytopathological problems could be solved with the use of compost.

Durable success can only be obtained if a quality management is resolutely followed. Further research is needed to optimize the quality management of compost production and utilization. For example, very little is known about the long-term effect of the different composts on soil fertility and disease receptivity.

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