Trichoderma in the Fight Against Root Rot in *Zantedeschia* Tuber Production©

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INTRODUCTION

Zantedeschia hybrids (coloured arum or calla lilly) is quite a difficult crop to grow due to its susceptibility to root rot. Primary infection by a complex of pathogens from the genera *Phytophthora*, *Rhizoctonia*, *Fusarium,* and *Pythium* often leads to secondary bacterial infection of *Erwinia.* While irrigation and environmental conditions play a very big role in disease management, the use of fungicides becomes a necessity and sometimes quite an extraordinary expense, while crop losses remain high.

Observation of wild as well as garden-grown coloured *Zantedeschia* indicates relatively good health and resistance to disease and even increased tuber production with minimal inputs as opposed to high intensity cultivation in "artificial" growth medium. Figure 1 shows two tubers both grown for two crop cycles, one in an intensive crop system with coir and bark as grow medium and under 40% shade; the second in a garden in Midrand, South Africa, on an east-facing wall. A lack of soil minerals, as well as beneficial soil organisms are thought to play an important role in disease pressure in commercial production systems, and of course the monoculture aspect where diseases can easily spread from host to host. Other issues like nutrition, irrigation, temperature, and light intensity also would need further investigation to optimise tuber size.

In this presentation the use of *Trichoderma harzianum,* a naturally abundant soil fungus that is commercially used against above-mentioned pathogens as a biological control measure is discussed. Firstly as an alternative to chemical fungicides (mancozeb, metalaxyl, propomocarb, and benomyl) and secondly as additive use in an integrated pest management (IPM) program, alongside the incorporation of soil minerals in the form of volcanic rock dust.

Trials are currently ongoing at Emerald Green Horticulture (EGH), a commercial plant production facility. Harvest data is not yet available, although some clear comparisons can be made between various treatments. This paper will serve to communicate the experience gained in using these chemical and biological disease control measures, as well as mineral additives, towards better implementation and disease suppression in commercial production systems at EGH.

BACKGROUND

Growing Medium and Culture Cycle. When hardening off tissue cultured plants, EGH uses a coir and pine bark (1 : 1, v/v) mix in planting crates, with no mineral soil. This mix is chosen due to its availability, ease of use (weight), excellent water holding and air-filled porosity, and lack of inherent pathogens. The initial trial was done with re-used medium (used for one culture cycle before), without any other sterilisation or treatment other than stated. The second round of trials were done with fresh medium prepared as described.

Figure 1. The tuber on the left is a typical size harvested from intensive production systems after the 2nd-crop cycle. Tuber on the right is a garden grown tuber also after the 2nd-crop cycle.

The coir is pre-treated (buffered) with calcium and magnesium dissolved in water while compressed blocks are being expanded, generally a day before the mix is to be used. At this stage the various additives (treatments) are added to the coir before mixing with fine bark and filling up of planting crates commence. The dimensions of the planting crates are 57 × 40 × 17 cm with slits in the bottom for drainage and handles for ease of carrying (reducing effective depth) containing a volume of approximately 25-L medium.

Thirty-five *Zantedeschia* plantlets are planted per crate, hardened off for a period of 4–6 weeks in humidity-controlled growing tunnels and grown on for another 25–30 weeks in the same crates, after which tubers are harvested.

Biological Control: *Trichoderma.* *Trichoderma harzianum* is used as a biocontrol agent and has found to be effective as antagonist to various fungal pathogens, such as *Fusarium, Pythium,* and *Rhizoctonia.* The effectivity of *Trichoderma* is based on different mechanisms, such as the production of antifungal metabolites, competiveness, as well as myco-parasitism (Kredics et al., 2003). It colonises the roots of plants and aids in uptake of nutrients by the plant by solubilising minerals, thus reducing plant stress, as well as enhancing the plant's immune response.

In these trials a commercially formulated wettable powder of *T. harzianum* strain kd containing 2×10^9 conidia per gram was used, trade name Eco-T. The supplier stated that this strain was resistant to all fungicides, excluding those from the triazole group. It is applied as drench or incorporated into medium before planting.

Mineral Additive: Volcanic Rock Dust. Volcanic rock dust is used as an additive for mineral poor soils usually in conjunction with "efficient microbes" to assist in making these minerals more soluble and available for plant uptake. The most abundant mineral, silicone, is thought to be effective in alleviating abiotic and biotic stress by enhancing plants immune responses to pathogens through mechanical and physiological means (Fauteux et al., 2005). In EGH production systems where growing medium based on bark and coir (as opposed to mineral soil) is used with soluble fertiliser, this element might be a limiting factor.

Volcanic rock dust, brand name Turbo-Grow, was used with chemical composition shown (as per the supplier) below for the major elements in percent weight.

Table 1. Major elements by weight (%) (supplier provided) in Turbo-Grow volcanic rock dust.

Element	Weight (%)
SiO_2	48.58
TiO_2	0.91
Al_2O_3	16.32
Fe_2O_3	9.30
MnO	0.18
MgO	6.36
CaO	12.11
Na_2O	2.32
K_2O	0.58
P_2O_5	0.15
Cr_2O_3	0.02

Fungicides. Metazeb containing metalaxyl and mancozeb as a wettable powder formulation containing 100 $g{\cdot}kg^{-1}$ and 600 $g{\cdot}kg^{-1}$ of the respective active ingredients is generally used by EGH at planting (incorporated into medium) and during culture as a spray at 3-week intervals. This fungicide is also premixed in the medium before planting.

Other fungicides regularly used at EGH includes propomocarb, benomyl, and copperoxychloride at various intervals or as required.

METHODS AND RESULTS

Trial 1. During the first trial recycled medium was used. The mix consisted of coir and bark (1 : 1, v/v) that was used for the previous season's crop of zantedeschia tubers. It was stored outdoors for approximately 2 months before being re-used and wasn't completely rewetted before use and plants were considered to be stressed during hardening-off.

Ex in vitro plantlets were planted into the medium (in crates as described above) and given a drench after planting. One treatment consisted of a drench with Eco-T at a rate of 4 $g{\cdot}L^{-1}$ and 10 L treating 15 crates. The other treatment consisted of a drench with Metazeb at a rate of 2 $g{\cdot}L^{-1}$ and 10 L treating 15 crates. The visual results of the trials after 16 weeks of growth are shown in Figs. 2 and 3.

The photographs illustrate that *Trichoderma* might assist in reducing transplant shock when conditions are suboptimal, as many more of the Metazeb-treated plot fell out due to low availability of water. There was no significant difference between the sizes of tubers or roots formed after 16 weeks between the two plots. Throughout the rest of the culture cycle, some evidence of vascular rot was visible in the Eco-T-treated plot and Metazeb and benomyl sprays as well as one propomocarb drench was subsequently applied. It became apparent that Eco-T on its own won't be sufficient to suppress all rot-causing pathogens without the aid of fungicides.

Figure 2. *Zantedeschia* plantlets after Eco T treatment.

Figure 3. *Zantedeschia* plantlets after Metazeb treatment.

Figure 4. *Zantedeschia* plantlets treated with Metazeb only after 5 weeks' growth.

Trial 2. For the second trial fresh medium was used also consisting of a coir and bark (1 : 1, v/v) mix. The medium was thoroughly wetted before use and plants were not considered to be under abnormal stress. The first treatment was buffered coir and bark, with 300 ml Metazeb added to 5 blocks of coir before mixing with bark, translating into 10 ml per 25 L medium. For the second treatment, 300 ml Metazeb, 150 ml Eco-T, and 5000 ml Turbo-Grow was added to the blocks of coir while buffering and before mixing with bark, (translating into 10, 5, and 150 ml each per crate). Figures 4 and 5 show the visual results of the trial after 5 and 3 weeks' growth, respectively.

From Figs. 4 and 5 it is clear that the plants treated with Metazeb, Eco-T, and Turbo-Grow adapts more easily to the new environment as opposed to plants only treated with Metazeb. This is probably due to enhanced root functionality.

CONCLUSION

Both trials show that Eco-T does assist in alleviating transplant shock, enabling plants to harden off and grow quicker after de-flasking. During the first trial it became clear that Eco-T on its own wasn't suppressing all of the rot-causing pathogens and that Eco-T in conjunction with other fungicides might be the best option.

The continuation of this trial will give an indication of *Trichoderma* as a biocontrol agent against pathogens in the soil. It is expected that less chemical fungicides will be required in the Eco-T and Turbo-Grow treated plot. This might result in the reduced

Figure 5. *Zantedeschia* planlets treated with Metazeb, Eco T, and Turbo Grow at 3 weeks' growth.

requirement for chemical fungicides and could be used as an additive or even synergistic measure to a more ecologically and economically sound IPM program.

Disclaimer: The author has no affiliation to the products' manufacturers or distributors mentioned in this paper and no endorsement is intended.

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