Seedling quality, plant growth and fruit yield and quality of tomato (*Solanum lycopersicum* L.) in response to *Trichoderma harzianum* and arbuscular mycorrhizal fungi

By

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DECLARATION

I, Bombiti Nzanza, hereby declare that the thesis, which I hereby submit for the degree of Doctor of Philosophy at the University of Pretoria, is my own work and has never been submitted by myself at any other University. The research work reported is the result of my own investigation, except where acknowledged.

B Nzanza

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LIST OF ACRONYMS AND ABBREVIATIONS

AA	Antioxidant activity
AMF	Arbuscular mycorrhizae fungi
An	*Ascorphollum nodosum*
AOAC	Association of official analytical chemists
B	Boron
BCA	Biological control agent
C	Carbon
ca.	Approximately
Ca	Calcium
CEC	Cation exchange capacity
CFUs	Colony forming units
Cu	Copper
DAG	Days after germination
DGGE	Denaturing Gradient Gel Electrophoresis
DI	Disease index
ELF	Extra large fruit
Em	*Ecklonia maxima*
FAO	Food and Agricultural Organization
Fe	Iron
FM	Fresh mass
GI	Germination index
GUS	b-glucuronidase
IAA	Indole acetic acid
ICO-AES	Inductively Coupled Plasma-Atomic Emission Spectroscopy
ICP	Inductive Coupled Plasma
ITS	Internal Transcribed Spacer
K	Potassium
LC	Lycopene content
LF	Large fruit
M	Mycorrhizae
MF	Medium fruit
Mg	Magnesium
MGT	Mean germination time
Mn	Manganese
Mo	Molybdenum
MYC	Myecocytomatosis viral oncogene
MYP	Marketable yield per plant
N	Nitrogen
Na	Sodium
NaCl	Sodium Chloride
NaOCl	Sodium hypochlorite

NFP	Number of fruit per plant
P	Phosphorus
PAUP	Phylogenetic Analysis Using Parsimony
PCR	Polymerase chain reaction
PDA	Potato dextrose agar
PGPR	Plant growth-promoting rhizobacteria
RDNA	Ribosomal DNA
RI	Retention indices
RMC	Reduced mycorrhizal colonisation
RRNA	Ribosomal RNA
S	Sulphur
SF	Small fruit
SG	Speed advantage
SG	Germination speed
Si	Silicon
Spp.	Species
SWE	Seaweed extracts
T	*Trichoderma*
TBR	Bisection reconnection
TSS	Total soluble solids
TTV	Total treatment variation
TYP	Total yield per plant
USEPA	United State Environmental Protection Agency
VC	Vitamin C
Vd	*Verticillium dahliae*
Wp	Water primed
Zn	Zinc

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DEGREE: PhD

ABSTRACT

Existing evidence suggested that nursery inoculation with *Trichoderma harzianum* and arbuscular mycorrhizal fungi (AMF) could reduce deleterious effects of biotic and abiotic stresses and improve seedling quality, fruit yield and quality of tomato (*Solanum lycopersicum* L.). However, studies of their combined inoculation on seedling growth, fruit yield and quality of tomato plants are not well-documented. Experiments were carried out to investigate the combined effect of *T. harzianum* and AMF on tomato crop performance under various conditions. When combined with a *T. harzianum* and AMF mixture, seaweed extract from

Ecklonia maxiama inhibited AMF root colonisation of tomato seedlings. Treating seedlings with a mixture of *T. harzianum* and AMF reduced the incidence of *Verticillium* wilt in tomato grown in a nethouse at early season, with negligible effect on fruit yield. Further investigations were initiated to find out whether *T. harzianum* and AMF were efficient when applied as a mixture or alone, at different inoculation times. Co-inoculation with *T. harzianum* and AMF (*Glomus mosseae*) improved seedling growth and development, except when both fungi were simultaneously applied two weeks after sowing. When the seedlings were allowed to grow up until full harvest in a greenhouse, both fungal inoculants increased total yield and marketable yield, but these increases were not significant. Furthermore, inoculation with AMF increased the percentage of extra-large fruit. Field experiments conducted under commercial tomato production confirmed greenhouse studies. Inoculation of tomato with *T. harzianum* and AMF, either alone or in combination increased early fruit yield (four first harvesting weeks). Throughout the studies, percentage AMF root colonisation in seedlings and plants remained low, despite nursery inoculation. Field experiments investigated the effects of AMF-inoculated transplants combined with biochar-amended soils on AMF root colonisation and their resultant effects on overall crop performance and microbial community structure. Biochar had no effect on AMF root colonisation, and also when combined with AMF, it had no influence on tomato productivity. Interestingly, biochar altered the fungal community while AMF might have influenced the bacterial community such as plant-growth promoting rhizobacteria, which are associated with improved plant growth, nutrient uptake and disease control in the rhizosphere. These benefits could contribute to improved yield and fruit quality. In conclusion, although the results were variable, there was a clear indication that *T. harzianum* and AMF can play an important role in tomato production.