

Synthesis, Characterization and Antifungal Activity of Different Nanomaterials Against Phytopathogenic Fungi

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تصنيع وتوصيف بعض مضادات الفطريات النانوية وإستخدامها ضد الفطريات الممرضة للنبات

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7-Summary

1. Samples of seedlings infected with damping-off or root rot of adult plants were obtained from different locations at Giza governorate. The samples yielded 25 fungal isolates. Isolates were identified as *Rhizoctonia solani* (44%), *Fusarium* spp. (44%) and *Macrophomena phasolina* (12%).
2. In pre-emergence stage of cotton seedlings, twenty four fungal isolates were pathogenic on Giza90, while all fungal isolates were pathogenic on Giza94 compared to the control. On Giza90, *Fusarium* isolate F10 (80.000%), *Rhizoctonia solani* RS9 (100.000%), *Macrophomena phasolina* M4, and M12 (34.000%) were the most pathogenic isolates, while on Giza 94, *Fusarium* isolate F10 (100.000%), *R. solani* RS9 (100.000%), *M. phasolina* M4 (64.000%) were the most pathogenic isolates.
3. In post-emergence stage of Giza 90, *Fusarium* isolate F1 (22.000%), *R. solani* RS11 (18.000%), *M. phasolina* M4, and M12 (48.000%) were the most pathogenic isolates, while on Giza 94, *Fusarium* isolate F1 (16.000%), *R. solani* RS4 (14.000%), and *M. phasolina* M4 (24.000%) were the most pathogenic isolates.
4. All fungal isolates were pathogenic and decreased survival percentage on the two cultivars. On Giza 90, *Fusarium* isolate F10 (00.000%), *R. solani* RS9 (00.000%), and *M. phasolina* M4 (18.000%) were the most effective isolates in decreasing survival, while on Giza 94, *Fusarium* isolate F10 (00.000%), *R. solani* RS9 (00.000%) group, and *M. phasolina* M4 (16.000%) were the most effective isolates in decreasing survival.
5. The most effective fungal isolates that decreased plant height and dry weight for both cultivars were F10, RS9 and M4.
6. All tested *Trichoderma* isolates were effective and caused inhibition of linear growth of all pathogenic fungal isolates F10, Rs9, and M4 under in vitro conditions. *Trichoderma* T_{vivi} was the most effective isolate against F10 as it inhibited growth by 85.9%, while against (Rs9), *Trichoderma* T₂₈ was the most effective one as it inhibited growth by 52.6%. Against *M. phasolina* (M4), *Trichoderma* T₃₄ was the most effective one as it inhibited growth by 70.46%.
7. All concentrations of Maxim XL were effective in decreasing the linear growth of *Trichoderma* T₂₈ in vitro compared to the control, and concentration 25% was the least effective one in decreasing the linear growth as it decreased linear growth to 4.917cm compared to control (9 cm). All concentrations of Moncut were effective in decreasing the linear growth of *Trichoderma* T₂₈ compared to the control, and concentration 50% was the

- least effective one in decreasing the linear growth as it decreased linear growth to 2.917cm compared to control (9 cm). On Eleven, all concentrations were equally effective in decreasing the linear growth of *Trichoderma* T₂₈ compared to the control, and decreased the linear growth to 1cm compared to control (9 cm).
8. All concentrations of Maxim XL were effective in decreasing the linear growth of *Trichoderma* T₃₄ in vitro compared to the control, and concentration 25% was the least effective one in decreasing the linear growth as it decreased linear growth to 3.750cm compared to control (9 cm). on Moncut, all concentrations were effective in decreasing the linear growth of *Trichoderma* T₃₄ compared to the control, and concentration 25% was the least effective one in decreasing the linear growth as it decreased linear growth to 7.667cm compared to control (9cm). On Eleven, all concentrations were effective in decreasing the linear growth of *Trichoderma* T₃₄ compared to the control, and concentration 25% was the least effective one in decreasing the linear growth as it decreased linear growth to 2.000cm compared to control (9 cm).
 9. All concentrations of Maxim XL were effective in decreasing the linear growth of *Trichoderma* T_{vivi} in vitro compared to the control, and concentration 25% was the least effective one in decreasing the linear growth as it decreased linear growth to 5.250 cm compared to control(9cm). On Moncut, all concentrations were equally effective in decreasing the linear growth of *Trichoderma* T_{vivi} compared to the control, and concentration 50% was the least effective one in decreasing the linear growth as it decreased linear growth to 6.333cm compared to control (9 cm). On Eleven, all concentrations were effective in decreasing the linear growth of *Trichoderma* T_{vivi} compared to the control, and decreased the linear growth to 1.000cm compared to control (9 cm).
 10. Combinations of seed dressing fungicides and *Trichoderma* isolates were evaluated as to their effects on susceptibility of cotton cultivars to *F. fujikuroi*(F10) under greenhouse conditions. From the practical point of view, using of biocide *Trichoderma* T_{vivi} (Treatment 16) the best one for both cultivars and it did not include chemical fungicides. The maximum value of plant height for both cultivars was moncut(0.5g) + T₃₄ (7g) and represented by treatment 11 (20.174cm). The maximum value of dry weight for both cultivars was moncut(0.5 g)+T_{vivi}(7g) and represented by treatment 10 (1.822 g).
 11. As to *R. solani* (RS9), using of biocide *Trichoderma* T₂₈ (Treatment 18) was a good one for both cultivars as it did not include chemical fungicides, and the difference between it and the best treatment, which include chemical fungicide (Treatment13) was non-significant. The

maximum value of plant height for both cultivars was Maxim xl (0.5 ml) and represented by treatment 14 (21.670cm). The maximum value of dry weight for both cultivars was Maxim xl(0.5ml)+T28(7g) and represented by treatment 15(1.897g).

12. For *M. phasolina* (M4) using of biocide *Trichoderma* T34 (Treatment 17), which increased was a good one for both cultivars. as it did not include chemical fungicides. The maximum efficiency for plant height in controlling the disease was T_{vivi}(7g) and represented by treatment 16(22.737cm). The maximum efficiency for dry weight in controlling the disease was T34 (7g) and represented by treatment 17 (2.632g).
13. The effect of culture filtrates of *Trichoderma* isolates on survival and radical length of cotton cultivars in vitro was evaluated. Most of *Trichoderma* isolates were pathogenic or highly pathogenic on both cotton cultivars, five isolates were non pathogenic and did not show significant difference from control on Giza90. Only *Trichoderma* T_{vivi} increased survival percentage significantly on Giza94. Eleven *Trichoderma* isolates decreased radical length significantly.
14. Under greenhouse conditions, the effect of the non pathogenic five isolates in vitro on Giza90 was tested and *Trichoderma* T₄₇ increased the survival to 93.334% followed by T₂ which increased survival to 91.667% on both cultivars. The most effective *Trichoderma* isolates on plant height was *Trichoderma* T₄₇. The effect of *Trichoderma* isolates in vitro and under greenhouse conditions were not the same and the response of the cotton cultivars was also different.
15. AgNPs was biosynthesized from *Trichoderma* extract of Tvivi, T34 and T28 by green synthesis using *Trichoderma* without using any harmful reducing agents such as sodium borohydride and any other capping or dispersing agent.. Characterization of the synthesized nanoparticles by Tvivi, operated via UV-Visible Spectral, Dynamic light scattering (DLS), Zeta Potential analysis, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and Energy dispersive x-ray (EDX) revealed that the particles were AgNPs with a spherical shaped particles. The nanoparticles were individuals and agglomerated in clusters. Particle size given by DLS was at average 52.34 nm and 0.559 PdI value. Particle size was within the range 6-15nm under TEM. and zeta potential of -25.1.mV.
16. All concentrations of AgNPs(20, 40, and 100 µg/mL) were effective in decreasing the linear growth of all fungi compared to the control, and concentration AgNPs100µg/mL was the most effective one in decreasing the linear growth as it decreased linear growth to 4.000, 2.250 and 4.167cm compared to control (9 cm)for F10, Rs9 and M4,respectively. On both

cotton cultivars, all treatments were effective in controlling disease and increasing survival regardless of fungus, however, treatment AgNPs (100µg/mL) was the least effective treatment, under greenhouse conditions.

17. ZnO-NPs was synthesized from *Trichoderma* extract of Tvivi, T34 and T28, which has advantages such as inexpensive, simple work-up, costly and safe method. Characterization of the synthesized nanoparticles by Tvivi operated via UV-Visible Spectral, X-Ray Diffraction (XRD), Zeta Potential analysis, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Fourier Transforms Infrared Spectroscopy (FTIR) Analysis and Energy dispersive x-ray (EDX) revealed that the particles were ZnO-NPs with a mixture of hexagonal, spherical, and rod shaped particles with crystalline structure. The nanoparticles were individuals and agglomerated in clusters. Particle size was within the range 8- 23nm and zeta potential of -24.0mV.
18. Three concentrations (20, 40, and 100 µg/ml) of the synthesized Zno nanoparticles were evaluated in vitro against *R. solani* (RS9), *F. fujikuroi*(F10) and *M. phasolina* (M4), the mycelial diameter was completely reduced by 100% in all tested concentrations for all tested fungi. All treatments were effective in increasing survival and controlling disease regardless of fungus on Giza90, however Zno NPs(100µg/ml) showed the least efficiency in controlling disease. All treatments were effective in increasing survival and controlling disease regardless of fungus on Giza94 except Zinc(100µg/ml) was ineffective in controlling disease. Moncut(2g) showed the maximum efficiency in controlling disease regardless of fungus (88.889% survival) followed by Maxim XL(2ml) and Zno NPs(200µg/ml) .`
19. ZnO-Chitosan nanocomposites was synthesized and characterized by UV-Visible Spectral, X-Ray Diffraction (XRD), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and Energy dispersive x-ray (EDX) revealed that the particles were ZnO-Chitosan nanocomposites with a mixture of hexagonal and spherical shaped particles with crystalline structure. The nanoparticles were individuals and agglomerated in clusters. Particle size was within the range 6-18nm.
20. Three concentrations (20, 40, and 100 µg/ml) of the synthesized nanocomposites were evaluated in vitro against *R. solani* (RS9), *F. fujikuroi* (F10) and *M. phasolina* (M4), the mycelial diameter was completely reduced by 100% in all tested concentrations for all tested fungi. On Giza90, all treatments were equally effective in increasing survival and controlling disease regardless of fungus. On Giza94, All treatments were effective in controlling the disease, treatment Z/C (100µg/ml) was the least effective treatment while other treatments were equally effective.