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INTEGRATED CONTROL FOR NECK ROT DISEASE OF ONION

BY

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6. SUMMARY

The present study aimed to find out eco-friendly alternative control approaches for onion neck rot disease. These alternatives include the resistant onion cultivars, in which the susceptibility of some Egyptian cultivars to infection with *B. allii* was investigated in the greenhouse and field experiments. In addition, carbon, magnesium oxide, and zinc oxide nanoparticle materials, antioxidants, plant extracts, and biocontrol agents were evaluated against the growth of *B. allii* *in vitro* and for their control efficacy in the greenhouse and field as well as storage. Another objective was to study the integration between the effective control agents to minimize the incidence of onion neck rot disease compared with a fungicide treatment.

Results of the present work can be summarized as follows:

- 1 - Isolation from diseased onion plants showing neck rot symptoms collected from Juhanah, Gerga, Alasairat, Dar El Salam, El Balyana, El Munshah, Sohag, Akhmem, Saqultah, El Maragha, Tahta, and Tema of Sohag Governorate resulted in a total of 14 fungal isolates that were identified as *Botrytis allii* Munn (12 isolates) and *B. cinerea* Pers. (2 isolates).
- 2 - The pathogenic capability of 14 isolates of *B. allii* (12) and *B. cinerea* (2) was tested on the onion cv. Giza 20 in the open greenhouse. Results showed that only isolates of *B. allii* were pathogenic to onion bulbs and caused identical neck rot symptoms among all tested isolates.

3 -The influence of nanomaterials carbon, MgO, and ZnO at different concentrations 0.0, 0.1, 0.2, and 0.3 mM on the mycelial linear growth and biomass of *B. allii* was studied. Results showed that all tested nanomaterials significantly decreased the mycelial linear growth and biomass at all tested concentrations. Furthermore, the highest inhibitory effect on the fungal growth was detected for nano MgO, particularly at 0.3 mM, where it caused a high reduction in the mycelial linear growth and biomass. While nano carbon at 0.3 mM caused the lowest inhibitory effect.

4 - The influence of the antioxidants humic acid, salicylic acid, and pyrogallol acid at different concentrations 0, 10, 15, and 20 mM on mycelial linear growth and biomass of *B. allii* was also studied. Results showed that all tested antioxidants significantly reduced the mycelial linear growth and biomass at all tested concentrations. The highest inhibitory effect on the fungal growth was detected for salicylic acid, particularly at 20 mM, where it caused a high reduction in the mycelial linear growth and biomass. In contrast, humic acid at 20 mM caused the lowest inhibitory effect.

5 - Effects of extracts from garlic, camphor, coriander, fleabane, and thyme plants at different concentrations 0, 10, 30, and 50% on the mycelial linear growth and biomass of *B. allii* were investigated. Results showed that all tested plant extracts significantly reduced the mycelial linear growth and biomass at all tested concentrations. The highest inhibitory effect on the fungal growth was detected for coriander extract, particularly at 50%, where it caused a high reduction in the

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mycelial linear growth and biomass. In contrast, fleabane extract at 50% induced the lowest inhibitory effect and slightly reduced the mycelial linear growth and biomass.

6 - Eight bacterial and fungal isolates belong to *B. subtilis* (4 isolates), and *T. harzianum* (4 isolates) were tested for their antagonistic activity against *B. allii*. Results indicated that all tested bacterial and fungal isolates significantly inhibited the mycelial growth of *B. allii in vitro*. However, isolates of *T. harzianum* were more effective in reducing the mycelial growth of *B. allii* than *B. subtilis* isolates. Isolate No. 2 of *T. harzianum* caused the highest inhibition zone, followed by isolate No. 1. of *T. harzianum*. While isolate No. 3 of *T. harzianum* caused the lowest inhibition zone, followed by *B. subtilis* isolate No. 4.

7 - The susceptibility of some onion cultivars to infection with *B. allii* showed that out of the four onion cultivars tested to the infection with *B. allii*, Giza 20 cv. was the most susceptible ones to neck rot disease, where it exhibited 91.33 and 86.67% of DI and DS, respectively, followed by White cv. In contrast, Giza 6 cv. was the least susceptible to the disease, which exhibited 46.67 and 34.67% of DI and DS, respectively, followed by Shandaweel 1 cv.

8 - The efficacy of some nanomaterials tested at different concentrations on the infection with *B. allii* causing neck rot disease of onion was studied. Results demonstrated that all tested nanomaterials significantly varied in their effectiveness on the incidence of neck rot disease. The highest efficiency of tested nanomaterials was detected for nano MgO, particularly at 0.3 mM. It caused the

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highest reduction in DI and DS. While nano carbon at 0.3 mM caused the lowest efficacy and slightly reduced the DI and DS. On the other hand, nano ZnO at 0.3 Mm decreased DI and DS to 37.33 and 25.33%, respectively.

9 - The efficacy of three antioxidants, humic, salicylic, and pyrogallic acids tested at 0, 10, 15, and 20 mM on the infection with *B. allii* of onion, was studied. Results showed that the tested antioxidants significantly varied in their effectiveness on the incidence of neck rot disease. The highest efficiency was detected for salicylic acid, particularly at 20 mM, which caused the highest reduction of DI and DS. In contrast, humic acid at 20 mM caused the lowest efficacy and slightly reduced the DI and DS. On the other hand, pyrogallic acid at 20 mM reduced DI and DS to 36.66 and 25.33%, respectively.

10 - Effects of extracts from garlic, camphor, coriander, fleabane, and thyme plants at different concentrations 0, 10, 30, and 50% on the infection with *B. allii* were investigated. Results showed that the plant extracts at all tested concentrations significantly varied in their effect on the infection with *B. allii*. The highest efficiency was detected for coriander extract, particularly at 50%, where it caused the highest reduction of DI and DS. In contrast, fleabane extract at 50% induced the lowest efficiency and slightly reduced the DI and DS, followed by camphor at 50%. On the other hand, garlic and thyme extracts at 50% reduced the DI and DS to (36.33 and 33.33%, respectively), and (46.33 and 39.33%, respectively).

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11- All tested bacterial and fungal isolates varied significantly in controlling neck rot disease of onion. All tested bacterial and fungal isolates significantly reduced the DI and DS and controlled neck rot disease. However, isolates of *T. harzianum* were more effective in decreasing DI and DS than *B. subtilis* isolates. Isolate No. 2 of *T. harzianum* caused the highest reduction of DI and DS, followed by *T. harzianum* isolate No. 1. In contrast, isolate No. 3 of *T. harzianum* caused the lowest decrease of DI and DS, followed by *B. subtilis* isolate No. 4.

12 - Susceptibility results of onion cultivars to infection with *B. allii* showed that out of the four onion cultivars tested to infection with *B. allii*, Giza 20 cv. was the most susceptible one to neck rot disease, where it exhibited 93.33 and 70.33% of DI and DS, respectively, followed by White cv. In contrast, Giza 6 cv. was the least susceptible to the disease, followed by Shandaweel 1 cv.

13 - The tested nanomaterials significantly varied in their effectiveness on the incidence of neck rot disease. The highest efficiency was detected for nano MgO, particularly at 0.3 mM. It caused the highest reduction of DI and DS. While nano carbon at 0.3 mM caused the lowest efficacy and slightly reduced the DI and DS. On the other hand, nano ZnO at 0.3 Mm decreased DI and DS to 66.66 and 46.66%, respectively.

14 - The tested antioxidants significantly varied in their effectiveness on the incidence of neck rot disease. The highest efficiency was detected for salicylic acid, particularly at 20 mM. It caused the highest reduction of DI and DS reached 39.66 and 23.66%, respectively. In contrast, humic acid at 20 mM caused the

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lowest efficacy and slightly reduced the DI and DS. On the other hand, pyrogallol acid at 20 mM reduced DI and DS to 49.33 and 28.66%, respectively.

15 - The plant extracts at all tested concentrations significantly varied in their effect on the infection with *B. allii*. The highest efficiency was detected for coriander extract, particularly at 50%, where it caused the highest reduction in DI and DS. In contrast, fleabane extract at 50% induced the lowest efficiency and slightly reduced the DI, followed by camphor at 50%. On the other hand, garlic and thyme extracts at 50% reduced the DI and DS to (43.33 and 39.33%, respectively), and (47.66 and 42.33%, respectively).

16- All tested bacterial and fungal isolates varied significantly in controlling neck rot disease of onion. All tested bacterial and fungal isolates significantly reduced the DI and DS and controlled neck rot disease. However, isolates of *T. harzianum* were more effective in lowering DI and DS than *B. subtilis* isolates. Isolate No. 2 of *T. harzianum* caused the highest reduction of DI and DS, followed by isolate No. 1. In contrast, isolate No. 3 of *T. harzianum* caused the lowest decrease of DI and DS, followed by *B. subtilis* isolate No. 4.

17- Out of the investigated four cultivars, Giza 20 cv. was the most affected one to neck rot disease, where it exhibited 91.20 and 53.55% of DI and reduction in bulb weight, followed by White cv. In contrast, Giza 6 cv. was the least affected by the neck rot disease, which exhibited 32.59 and 32.33% of DI and bulb weight reduction, followed by Shandaweel 1 cv.

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18 - The tested nanomaterials significantly varied in their effectiveness on the incidence of neck rot disease and the reduction in onion bulb weight during storage. The highest efficiency was detected for nano MgO, particularly at 0.3 mM, where it caused the lowest DI and the lowest reduction of onion bulb weight during storage. While nano carbon at 0.3 mM caused the lowest efficacy and slightly decreased the DI to 35.75%, and caused a reduction in bulb weight reached 31.74%. On the other hand, nano ZnO at 0.3 Mm reduced DI to 37.33% and caused a decrease in bulb weight reached 25.33%.

19 - The tested antioxidants significantly varied in their effectiveness on the incidence of neck rot disease and decline in bulb weight of onion during storage. The highest efficiency was detected for salicylic acid, particularly at 20 mM, where it caused the lowest DI and reduction in bulb weight. In contrast, humic acid at 20 mM caused the lowest efficacy, slightly reduced the DI to 46.23%, and caused a decrease in bulb weight reached 28.93%. On the other hand, pyrogallol acid at 20 mM reduced DI to 36.11% and caused a reduction in bulb weight reached 19.18%.

20 - The tested plant extracts significantly varied in their effectiveness on the incidence of neck rot disease and decline in bulb weight of onion during storage. The highest efficiency was detected for coriander extract, particularly at 50% mM, where it caused the lowest DI and bulb weight reduction. In contrast, fleabane extract at 50% induced the lowest efficacy, slightly reduced the DI to 48.30%, and caused a decrease of bulb weight reached 43.26%, followed by camphor at 50%.

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On the other hand, garlic and thyme extracts at 50% reduced the DI to 32.19 and 36.30%, respectively, and caused a reduction in bulb weight reached 24.18 and 27.63%.

21 - All tested bacterial and fungal isolates significantly varied in their effectiveness on the incidence of neck rot disease and reduction in bulb weight of onion during storage. All tested bacterial and fungal isolates significantly reduced the DI and bulb weight reduction of onion during storage. However, isolates of *T. harzianum* were more effective than *B. subtilis* isolates in such effects. Isolate No. 2 of *T. harzianum* caused the lowest DI and bulb weight reduction during storage reach 12.25 and 19.43%, respectively, followed by isolate No. 1 of *T. harzianum*. In contrast, isolate No. 3 of *T. harzianum* caused the highest DI and the lowest reduction in bulb weight of 43.25 and 31.37%, respectively, followed by *B. subtilis* isolate No 4.

22 - The effect of integration between effective control agents of onion cv. Giza 6 (A), 0.3 mM nano MgO (B), 40 mM salicylic acid (C), 50% coriander extract (D), and *T. harizantum* isolate No. 2 (E) on the infection with *B. allii* of onion was studied under field conditions during the 2019/2020 growing season. Results showed that all combinations of selected control agents significantly controlled the neck rot disease of onion and highly reduced the DI and DS. The highest reduction in DI and DS was detected when the integration A+B+C+D+E was applied, where it highly reduced the DI and DS to 3.33 and 0.33%, respectively, compared with the negative control of 92.33 and 68.33%, and positive control (Folicur fungicide)

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of 25.66 and 21.33%. While the integration A+B+C caused the lowest reduction in DI and DS. Finally, the integration between the onion cv. Giza 6 and 0.3 mM nano MgO, 40 mM salicylic acid, 50% coriander extract, and *T. harizantum* isolate No. 2 effectively controlled neck rot disease of onion caused by *B. allii*.