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EVALUATION OF VARIOUS FUNGICIDES AGAINST FUSARIUM SOLANI (MART.) SACC CAUSING SUDDEN DECLINE DISEASE OF DATE PALM (PHOENIX DACTYLIFERA L.) IN SINDH, PAKISTAN

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A B S T R A C T

Date Palm (*Phoenix dactylifera* L.) infected with sudden decline disease problem caused by *Fusarium solani* is considered as one of the most severe problem in Khairpur, Sindh, Pakistan. *F. solani* are thought to be a causative organism for this epidemiological problem. Six fungicides were tested such as Bavistin D.F, Topsin-M, Alliette, Ridomil gold, Mancozeb and Copper oxychloride at 0.5, 1.5 and 2.5 (g) concentrations against *F. solani* in potted date palm seedlings under greenhouse conditions. The result revealed that all fungicides significantly reduced the infection of *F. solani* on treated plants as compared to the control (un-treated plants. The significant differences obtained in terms of root and shoot length than untreated/control plantlets. The maximum root length was recorded using Bavistin D.F that also appeared as highly effective in terms of reducing the disease severity followed by Topsin-M, Alliete and Ridomil Gold whileMancozeb and Copper oxychloride were appeared as least effective.

Keywords: date palm, chemical control, *Fusarium solani*.

INTRODUCTION

Khairpur along with Makran district is the major date producing areas and source of about 80-90% of dates export from Pakistan. Since decade both areas are suffering from numerous pest and pathogen problems. Sudden Decline Disease (SDD) is one of the most problematic diseases of date palm (*Phoenix dactylifera* L.) and destroyed several orchards and dispersed trees in Khairpur, Sindh, Pakistan. This disease is caused by a soil born fungus *F. solani*, which is threatening date palm industry in this region (Maitlo *et al*., 2009; Abul Soad *et al*., 2011. The number of infected trees by this pathogen is increasing day by day but some areas of district Khairpur are considered as infection spots (Abul Soad *et al*., 2011). The disease progresses in infected date palm tree from base to apex. The initial symptoms occur on the lowest outer leaves of the middle crown. The color of the affected leaves change from normal green into pale green to yellow followed by discoloration of pinnae and spines with some dark spots and brown short streaks on the dorsal side of rachis and as the disease progresses, the symptoms appear on other leaves also showing profound yellowing; later on they became completely dead (Maitlo *et al*., 2014).The symptoms are similar to world famous bayoud disease of date palm caused by a destructive soil born fungus *F. oxysporium* f. sp. *albedinis* (Al-Akaidy, 1994). Bayoud first originated in North Africa particularly in Morocco, where more than 12 million trees of date palm have been destroyed within a century (Djerbi, 1983). The dominant fungi associated with date palm death and decline in Morocco were isolated and identified as *F. oxysporum, Diplodia phoenicum, Ceratocystis radicicola* and *Phomopsis phoenicola* (Ellis, 1977; Rattan and Al-Dboon, 1980; Mousiri *et al*., 2000).

The date palm crop can be protected from sudden decline disease by thoroughly spraying fungicides on

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whole tree or infected parts e.g. leave, stem and root against this disease. Every fungicide has its own mode of action and effects, some are broad systematic while others are target specific. The use of fungicides for the control of plant diseases is a common practice all over the world. There are several reports available in which fungicides have been used to control the plant diseases caused by soil born pathogens (Soad *et al*., 1982; llieseu *et al*., 1985; Rajput *et al*., 2006; Iqbal *et al*., 2010; Govindappa *et al*., 2011; Ahmed *et al*., 2012). Mahmood and Gill (2002) tested two fungicides Topsin-M and Benlate at various concentrations and found that Topsin-M at 50 ppm inhibited completely colony growth of *Botryodiplodia theobromae,* whereas Benlate at 100 ppm proved to be more effective against *C. gloeosporioides.*

The objectives of current study was to evaluate six different fungicides against the *F. solani* in potted date palm plantlets under control conditions and to determine the effect of soil amended fungicides on growth of inoculated and un-inoculated plants.

MATERIALs AND METHODS

The experiment was conducted at Date Palm Research Institute (DPRI), SALU, Khairpur in 2010. The plant material was obtained from DPRI Nursery.

Pathogen inoculum: The Pure culture of *F. solani* was isolated from different parts of affected date palm tree and maintained on potato dextrose agar (PDA) at room temperature.

Fungicides: The six different fungicides were used and grouped into 2 categories on the basis of their efficacy; Systemic and Contact fungicides. The systemic fungicides comprised of Bavistin D.F (Benzimidazole), Topsin M (Thiophanatemethyl), Ridomil gold (Phenylamide) and Alliette (Phosphonate) while the Contact fungicides comprised of Mancozeb (Dithiocarbamate) and Copper compound (copper oxychloride) (Table 1).

Table 1. List of fungicides and their active ingredients used against *F. solani*.

Trade Name	Chemical Name	Active ingredients	Formulation	Chemical group	Mode of Action
Bavistin D.F	Carbendazim	50% Carbendazim	50% WP	Benzimidazole	Systemic
Topsin-M	Thiophanate-methyl	70% Thiophanate-methyl	70% WP	Thiophanate-methyl	Systemic
Ridomil Gold	Methyl *N*-(2,6-dimethylphenyl)-*N*-(methoxyacetyl)-D-alaninate	Mefenoxam (47.6%)	25 WP	Phenylamide	Systemic
Aliette	Fosetyl-aluminum	80% Fosetyl-aluminum	80%WP	Phosphonate	Systemic
Dithane M-45	Mancozeb	80% Mancozeb	80% WP	Dithiocarbamate	Contact
Copper oxychloride	Copper oxychloride	50% Copper oxychloride	50% WP	Copper compound	Contact

Pot experiment: The healthy two months old date palm potted plantlets were inoculated with fresh culture of *F. solani* at 10 ml/plantlet along with 2 kg sterilized soil and kept under control conditions at DPRI greenhouse. The six different fungicides were applied such as Bavistin D.F, Topsin-M, Alliette, Ridomil gold, Mancozeb and Copper oxychloride at 0.5, 1.5 and 2.5 (g) concentrations and potted plantlets without any fungicide were considered as control. After 45 days of application plantlets were uprooted and the data related to plant growth like shoot length & weight and root length & weight was recorded. The disease severity was calculated with following formula as described by Baudian (1988) and Abdalla *et al*., (2000) using scale:

0-5 = 0: No infection.
1 = 1-10% damaged/ dark area around point of infection
2 = 11-25% gradual wilt occurred on plantlets
3 = 26-50% gradual wilt occurred on plantlets
4 = 51-75% gradual wilt occurred on plantlets
5 = 76-100% Died plantlets

The infection percent and disease severity was calculated with the help of following formula:

$$\text{Infection \%} = \frac{\text{Number of pieces colonized by the fungus}}{\text{Total number of pieces studies}} \times 100$$

Layout of the experiment: Each treatment comprised of three replicates. Randomized Complete Block Design was used and data were subjected to analysis of variance. Separation of means among treatments was determined using L.S.D test at 5% and 1% level of

significance (Steel *et al*., 1997).

RESULT AND DISCUSSION

The efficacy of six different fungicides was tested against *F. solani* the causative pathogen of sudden decline disease of date palm under greenhouse conditions in potted date palm plantlets. The obtained results showed that all fungicides significantly reduced the infection of fungus as compared to control at different concentrations but Bavistin, Topsin M, Alliette and Ridomil Gold at 2.5 (g) concentration were found to be the most effective in reducing the infection and disease severity. Whereas, copper oxychloride and Mancozeb appeared as less effective.

Effect of different fungicides on disease severity: The data presented in Figure 1 indicated that Bavistin D.F appeared as highly effective in terms of reducing the disease severity followed by Topsin-M. While, Alliete and Ridomil Gold were moderately effective as compared to Mancozeb and Copper oxychloride. It was also observed that the higher dosage of all fungicides were most effective in reducing the disease severity as compared to the lower ones. The disease severity percentages of different fungicides against *F. solani* inoculated potted plantlets at 0.5, 1.5 and 2.5 g/l concentrations were recorded is as follows: Bavistin D.F (15, 10 and 5) followed by Topsin M (20, 15, 10), Alliette (25, 20,15), Ridomil gold (30, 25 and 15), Mancozeb (55, 50, 45) and Copper Oxychloride (65, 60 and 55) as compared to untreated but pathogen inoculated plants (95.67%) respectively.

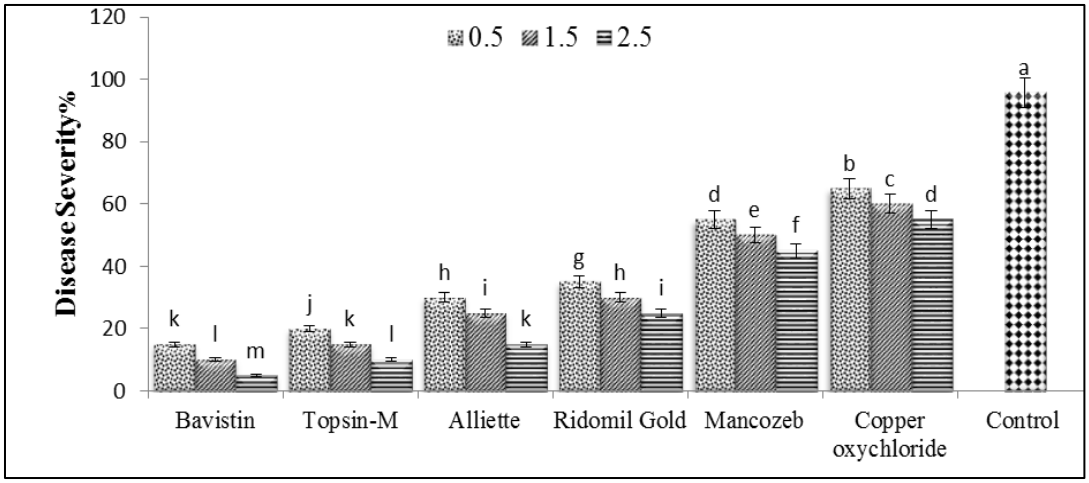

Figure 1. Effect of different fungicides on disease severity on date palm plantlets inoculated with *Fusarium solani.*

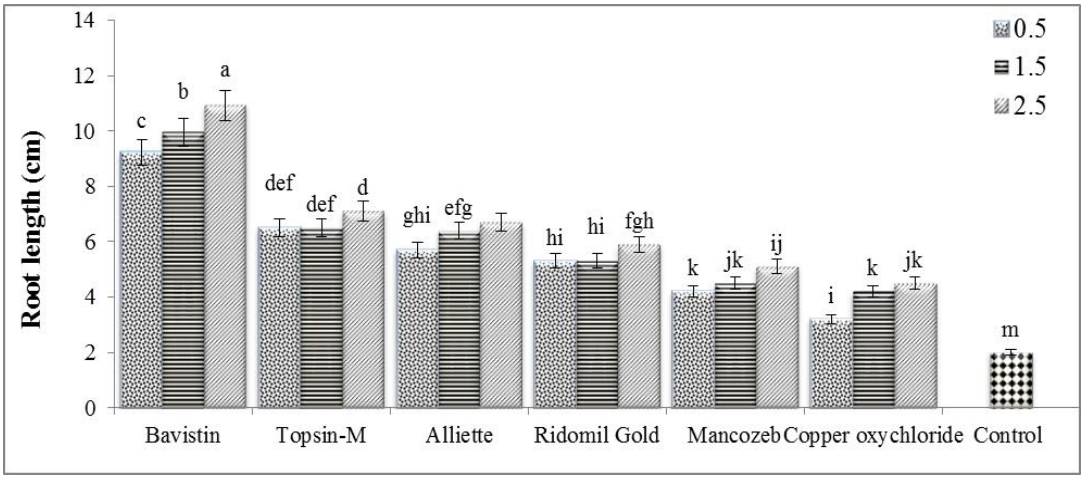

Figure 2. Effect of different fungicides on root length of date palm plantlets inoculated with *F. solani*.

The effectiveness of a fungicide depends on its innate toxicity and permeation. When applying on the surface of plant organs, fungicides destroy fungal spores or suppress germination tubes, hyphae and other fungal structures. However, the effectiveness of host resistance is curtailed by the occurrence of pathogenic races e.g. *F.*

oxysporum (Jimenez-Gasco *et al*., 2004). As for as the phenomenon behind the supreme efficacy of Systemic fungicides over Contact fungicides is concerned Jacob and Neumann (1987) in his findings mentioned that the protecting fungicides remain on the surface of the plant, do not penetrate in it or translocate within it, and have little or no effect on the pathogen established in plant tissue. While, the systemic fungicides are absorbed by the plant and translocate in it over the longer distance. In such a way, systemic fungicides translocate through the xylem and relatively small number of them has an ability to translocate basipetally in the phloem.

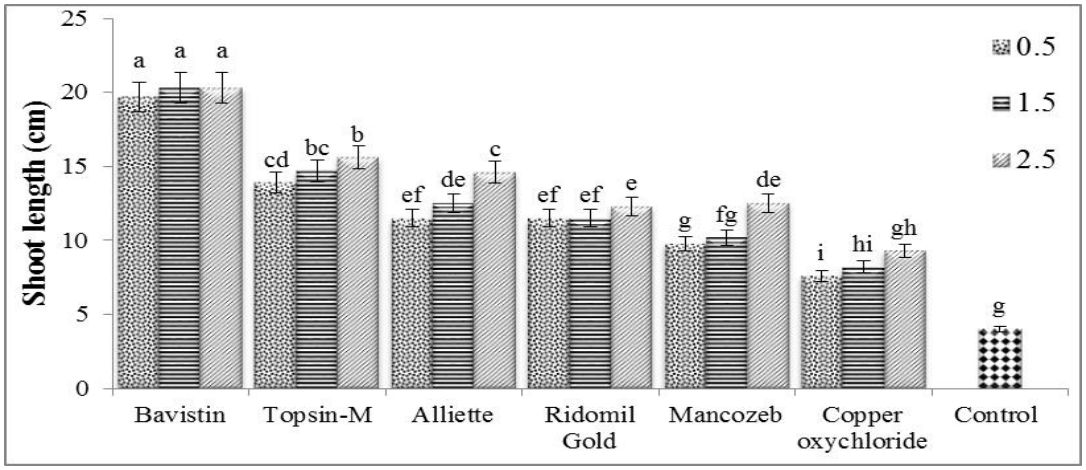

Figure 3. Effect of different fungicides on shoot length of date palm plantlets inoculated with *F. solani*.

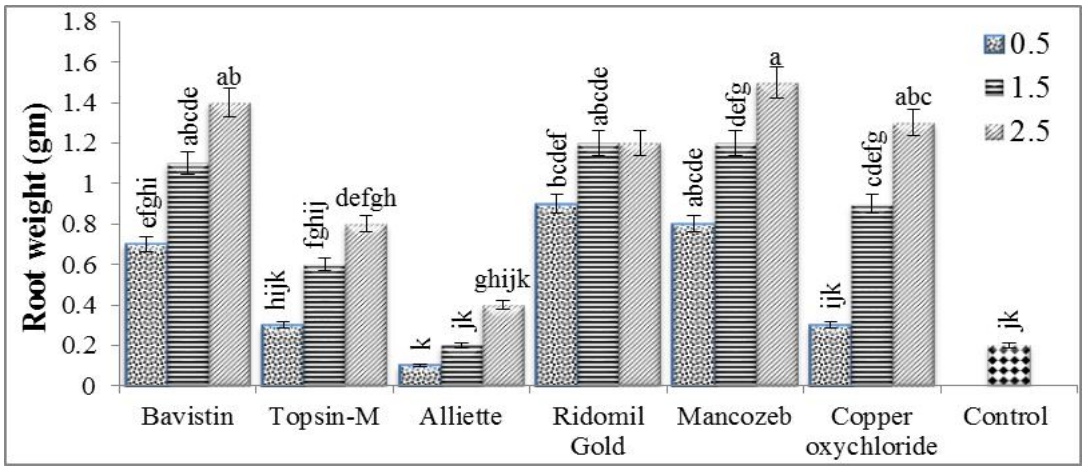

Figure 4. Effect of different fungicides on root weight of date palm plantlets inoculated with *F. solani*.

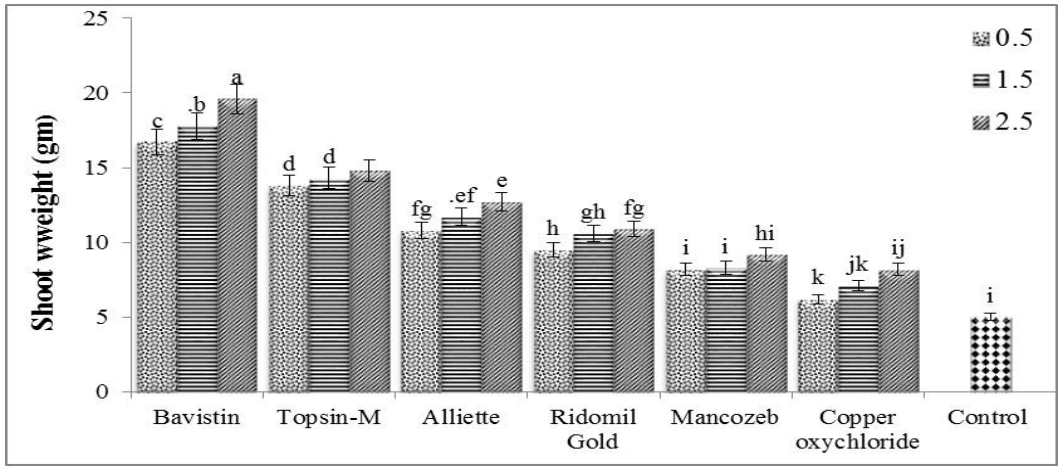

Figure 5. Effect of different fungicides on shoot weight of date palm plantlets inoculated with *F. solani*.

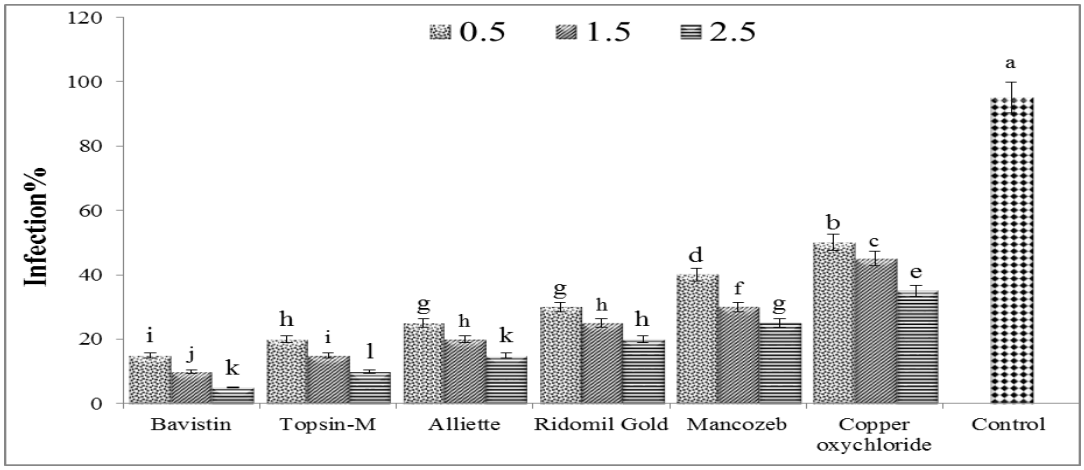

Figure 6. Effect of different fungicides on disease infection rate of date palm plantlets inoculated with *F. solani*

Similarly, Ilyas *et al*., (1992) while working on wilt in chickpea tested ten fungicides against the mycelial growth of *F. oxysporum* using soil drench method in potted plants in green house and found Benomyl as most effective followed by Rhizolax and Thiophanate-methyl.

Effect of different fungicides on root and shoot length: The pathogen inoculated potted plantlets treated with different fungicides showed significant differences in terms of root and shoot length than untreated/control plantlets (Figure 2 & 3). The maximum root length was recorded using Bavistin D.F at 0.5, 1.5 and 2.5 g/l concentrations (9.2, 9.9 and 10.5) followed by Topsin-M (6.5, 6.5 and 7.16 cm), Alliette (5.7, 6.4 and 6.7 cm) and Ridomil Gold (5.2, 5.3 and 5.9 cm) respectively. However, minimum root length was recorded in plants treated with Mancozeb at 0.5, 1.5 and 2.5 g/l concentrations (4.2, 4.5 and 5.1 cm) and Copper oxychloride (3.2, 4.2 and 5.5 cm) respectively as compared to the lowest root length obtained on control or untreated plantlets (2.1 cm). The results showed that the high dosage of all fungicides increased the root length as compared to their lower dosages. Whereas, the highest shoot length was recorded using Bavistin D.F at 0.5, 1.5 and 2.5 g/l concentrations (19.3, 20 and 20.3 cm) followed by Topsin-M (13.9, 14.7 and 15.6 cm) whereas Alliette was recorded (11.5, 12.5 and 14.6 cm) and Ridomil Gold (11.5, 12.3 and 11.5 cm). The lowest shoot was observed in plants treated with Mancozeb (9.8, 10.2 and 12.5 cm) and Copper oxychloride (7.6, 8.2 and 9.3 cm) as compared to control (4 cm).

Effect of different fungicides on root and shoot weight: However, maximum root weight was obtained in plantlets treated with Mancozeb at 0.5, 1.5 and 2.5 g/l concentrations (0.8, 1.2 and 1.5 g) followed by Bavistin D.F (0.7, 1.1 and 1.4 g), copper oxychloride (0.3, 0.9 and 1.3 g), Ridomil Gold (0.9, 1.2 and 1.2 g), Topsin M (0.3, 0.6 and 0.8 g), Alliette (0.1, 0.2 and 0.4 g) as compared to the control or untreated plantlets (0.2 g) (Figure 4).

The maximum shoot weight was recorded in plantlets treated with Bavistin D.F at 0.5, 1.5 and 2.5 g concentrations (16.7, 17.8 and 19.6 g) followed by Topsin M (13.8, 14.3, 14.3 g), Alliette (10.8, 11.7 and 12.7 g), Ridomil gold (9.5, 10, 10.9 g), Mancozeb (8.2, 8.3 9.2 g) and copper oxychloride (6.2, 7.1 and 8.2 g) respectively as compared to control (5.1 g) (Figure 5).

Pathogen infection

All fungicides significantly reduced the infection of *F. solani* as compared to the control or untreated plantlets. Among six fungicides Bavistin D.F and Topsin M were the most effective fungicides in reducing the infection of the pathogen inoculated date palm plantlets. The plantlets treated with Bavistin D.F at 0.5, 1.5 and 2.5 g/l concentrations showed 15, 10 and 5% followed by Topsin M (20, 15 and 10%), Alliette (25, 20 and 15%), Ridomil gold (30, 25 and 20%), Mancozeb (40, 30 and 25%) and Copper oxychloride (50%, 45% and 35%) respectively as compared to control (95%). east effective fungicides produced maximum infection as compared to the other fungicides (Fig. 6).

Many plant pathologists reported that several fungicides decreased the percentage of infection and disease severity (El-Zawahry *et al.*, 2000; Abdalla, 2002; Arain *et al.*, 2012). Generally, the fungicides application reduced the disease index before getting infection compared to the application after the infection. Our results are in

close confirmation with the findings of Khanzada *et al*., (2005) who recorded that wilt and dieback of mango caused by soil borne fungus was controlled by spray of carbendazim. Similarly, Watkins *et al*., (1977) have also reported the broad spectrum systemic fungicide is beneficial for the decreasing of disease incidence of date palm.

CONCLUSION

Sudden Decline Disease is a most problematic disease to the date palm orchards of the Khairpur region caused by F. solani and is much similar to the notorious Bayoud disease of date palm. The six different fungicides were tested against the F. solani in potted date palm plantlets. All the three concentration of Bavistin fungicide followed by Topsin-M was the best fungicides produced significantly maximum shoot length and weight as well as maximum root length and weight. The result showed that all fungicides significantly reduced the infection of *F. solani* on treated plants as compared to the control. The growers are recommended to apply systemic fungicides to control Sudden Decline Disease problem of date palm at early stage of infection while the highly infected date palm trees or trees in advanced stage must be removed from the orchards to stop further spread of disease in the neighboring areas.

REFERENCES

Abdalla, M.Y., A. Al Rokiba, A. Moretti and G. Mule. 2000. Pathogenicity of toxigenic *Fusarium proliferatum* from date palm in Saudi Arabia. *Plant Disease*, 84: 321-324.

Abul-Soad, A.A., W.A. Maitlo, G.S. Markhand and S.M. Mahdi. 2011. Date palm wilt disease (sudden decline syndrome) in Pakistan, symptoms and remedy. The blessed tree; Khalifa International Date Palm Award, UAE, 38-43

Ahmed, Z., F, Saifullah, Raziq, H. and M. Idress. 2012. Chemical and biological control of *Fusarium* root rot of Okra. *Pak. J. Bot.,* 44(1): 453-457.

Al-Akaidy, H.K.H. 1994. Science and technology of date palm cultivation Ekal-Press-Iraq

Arain, A.R., M.M. Jiskani, K.H. Wagan, S.N. Khuhro and M.I.Khaskhely. 2012. Incidence and chemical control of okra leaf spot disease. *Pak. J. Bot.,* 44(5): 1769-1774

Baudion, A.B. 1988. Laboratory Exercises in Plant Pathology: An Instruction Kit. St. Paul, Minnesota the American Phytopathological Society, 314.

Djerbi, D. 1983. Diseases of date palm (*Phoenix dactylifera L.*) Regional project for Palm and Date Research Centre in the Near East and North Africa, Baghdad. 106-110.

Ellis, M. B. 1977. Dematiaceous Hypomycetes. Common wealth Mycological Institute Kew Surrey, England. 608-612.

El-Morsi, M.E.A. 2004. Studies on certain fungal diseases of date palm off-shoots in New Valley, Egypt. Ph.D. Thesis, Fac. Agric., Assuit Univ., 110 .

El-Zawahry, M. Aida., M.A., Morsi and A.A., Elrazik.2000. Occurrence of fungal diseases on date palm trees and off shoots in New Valley governorate and their biological control. *Assiut. J. Agric. Sci*., 31(3): 189-212.

Govindappa, M., R.V. Ravishankar and S. Lokesh. 2011. *In vitro* and *In vivo* responses of different treating agents against wilt disease of safflower. *Journal of Cereals and Oilseeds*, 2(1): 16-25

Ilieseu, H., T. Sesan, N. Csep, A. Ionita, V. Stoica and M.Cariciu. 1985. Seed treatment an important link in the prevention and control of some cryptogenic diseases of sunflower. *Probleme de Protectia Plantelor*, 13: 173-188.

Ilyas, M.B., M.J. Iqbal and K. Iftikhar. 1992. Evaluation of some fungicides against *Fusarium* oxysporum f.sp. ciceris and chickpea wilt. *Pak. J. Phaytopahtol*., 4 (1-2): 5-8.

Iqbal, Z., M.A. Pervez, A. Ahmed, Y. Iftikhar, M. Yasin, A.Nawaz, M.U. Ghazanfar, A.A. Dasti and A. Saleem. 2010**.** Determination of minimum inhibitory concentrations of fungicides against \fungus *Fusarium magiferae*. *Pak. J. Bot*., 42(5): 3525-3532.

Jacob, F. and S. Neumann. 1987. Principles of uptake and systemic transport of fungicides within the plant. In: Modern Selective Fungicides - Properties, Applications, Mechanisms of Action, H. Lyr (Ed.), 13-30, Longman Scientific & Technical, Harlow, UK.

Jimenez-Gasco, M.M., J.A. Navas-Cortes and R.M. Jimenez-Diaz. 2004. The *Fusarium oxysporum* f.sp. Cicer arietinum pathosystem: a case study of the evolution of plant pathogenic fungi into races and path types*. Int. Microbiol*., 7: 95-104.

Khanzada, M.A., A.M. Lodhi, and S. Shahzad. 2005. Chemical control of *Lasiodiplodia theobromae*, the causal agent of mango decline in Sindh. *Pak. J. Bot*., 37(4): 1023-1030.

Maitlo, W.A., G.S. Markhand, A.A. Abul-Soad, A.M. Lodhi and M.A. Jatoi. 2014. Fungal pathogens associated to sudden decline disease of date palm (*Phoenix dactylifera* L.) and its incidence at Khairpur, Pakistan*. Pak. J. Phytopathol*., 26(1): 65-71.

Maitlo, W.A., G.S.Markhand, A.A. Abul Soad, M.A. Pathan and A.M. Lodhi. 2009. Comprehensive study on pathogen causing sudden decline disease of date palm (*Phoenix dactylifera* L.). Proceeding of the first International Dates Seminar, Date Palm Research Institute, Shah Abdul Latif University Khairpur, 71-76.

Mahmood, A, M.A, Gill, 2002. Quick decline of mango and *in vitro* response of fungicides against the disease. Int. J. Agric. Biol., 4: 39-40.

Mousiri, A., Lamari, L. and Saboon, N. 2000. Inventory of fungi of rhizospheres of the sensible and resistant palm to the bayoud in the region of Adrar (Algeria). Seventh Arab Congress of Plant Protection, 22-26 October 2000. Amman, Jordan.

Rajput, A.Q., M.H. Arain, M.A. Pathan, M.M. Jiskani and A.M. Lodhi. 2006. Efficacy of different fungicides against *Fusarium* wilts of cotton caused by *Fusarium oxysporum f.sp. vasinfectum*. *Pak. J. Bot*., 38(3): 875-880

Rattan, S.S and A.H.A., Al Dboon, 1980. Notes on fungi associated with date palm I. *Sydowia,* 32:246-273.Soad, M.B., A.A. El-Dib, A.A. El-Wakel, M.A.A. El- Gawwed and A.T. Thoma. 1982 Chemical control of root rot and wilt disease of sesame in Egypt. *Agric. Res. Rev*., 60: 117-126

Steel, R.G., J.H. Torrie and D. Dickey. 1997. Principles and Procedures of Statistics, a Biometrical Approach. The McGraw-Hill Co., Inc. New York.

Watkins, J.E., L.J. Littlefield and G.D. Statler. 1977. Effect of the systemic fungicide on the development *Puccinia recondita* f.sp. *tritici* in wheat" *Phytopathology*, 67: 985-980.