ISSN: 2467-9283

INTERNATIONAL JOURNAL OF GRADUATE RESEARCH AND REVIEW

website: www.ijgrr.org

INDEXING & ABSTRACTING

OPEN ACADEMIC JOURNALS INDEX (OAJI), INFOBASE INDEX, COSMOS, RESEARCHGATE, CITEFACTOR, SCHOLAR STEAR, JOURINFO, ISRA: JOURNAL-IMPACT-FACTOR (JIF), ROOT INDEXING ETC.

Impact Factors*

IBI factor: 3

Impact factor (OAJI): 0.101.

ISSN : 2467-9283
International Journal of Graduate Research and Review
A Multidisciplinary Journal

Research Article

Effect of Fungicides in Controlling Bulb Rot of Onion

K. M. Khalequzzaman[1*], M. S. Monjil[2]

[1]Spices Research Centre, BARI, Shibganj, Bogura, Bangladesh
[2]Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh

Article Information

Received: 15 April 2020
Revised version received: 15 May 2020
Accepted: 17 May 2020
Published: 29 May 2020

Cite this article as:
K.M. Khalequzzaman and M.S. Monjil (2020) Int. J. Grad. Res. Rev. Vol 6(2): 34-39.

***Corresponding author**
K.M. Khalequzzaman,
Principal Scientific Officer (Plant Pathology), Spices Research Centre, BARI, Shibganj, Bogura, Bangladesh
Email: zaman.path@gmail.com

Abstract

The experiment was conducted in sick plot at Spices Research Centre, BARI, Shibganj, Bogura, Bangladesh during Rabi season of 2017-18 to find out the effective control measure of basal or bulb rot of Onion. Bulb of BARI piaz 4 was used in this experiment. Six fungicides, healthy and fresh bulb and one control were the treatments. The lowest emergence (86.92%) of onion was recorded in control plots and the highest emergence (98.11%) was recorded in Bulb treatment and soil drenching with Amistar Top 325 SC. The lowest bulb rot incidence (8.76%) and highest disease reduction over control (70.52%) was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC. The highest bulb rot incidence (29.72%) was obtained from untreated control plots which was followed by Healthy and fresh Bulb (25.59%). The highest number of capsules per plant (448.05), number of seeds per capsule (4.73), seed yield per plant (6.18 g) and yield (750.56 kg/ha) were obtained from Bulb treatment and soil drenching with Amistar Top 325 SC and the lowest of these parameters were obtained from untreated control. Among the fungicides, Amistar Top 325 SC (0.1%), Cabriotop (0.3%) and Provax 200 WP (0.25%) were found individually more effective to control basal or bulb rot of onion, enhance growth attributes and yield. So, farmers and researchers may use Amistar Top 325 SC or Cabriotop or Provax 200 WP to decrease bulb rot incidence and increase seed yield of Onion.

Keywords: Fungicides; Bulb Rot of Onion; Amistar Top 325 SC; Cabriotop; Provax 200 WP

Introduction

Onion (*Allium cepa* L.) is one of the most economically important spice crops in Bangladesh. It can be grown from the tropics to sub-arctic regions. Onion is cultivated in winter (rabi) and summer (kharif) seasons in Bangladesh and maximum area under cultivation is being covered in rabi season. Onion is one of the most familiar spice crops throughout the world. It is also used as popular vegetable in Australia, Belgium, India, Japan, UK, USA and many other countries of Asia (Kukanoor, 2005). A good number of diseases have been reported in onion and cause production loss in the field and in storage (Munoz *et al*., 1984; Ahmed and Hossain, 1985; Meah and Khan, 1987). Onion production and quality are negatively affected by many foliar, bulbs, and root fungal pathogens. Onion and other *Allium* crops suffer from two major soil-borne diseases, Fusarium basal rot caused by *Fusarium oxysporum* f.sp. *cepae* and white rot caused by *Sclerotium cepivorum* causing various extents of losses. *Fusarium oxysporum* f. sp. *cepae* is a highly destructive pathogen that causes basal rot disease in onion resulting in significant yield losses of the crop in all growing areas of the world (Ozer and Koycu, 2004). Fusarium basal rot caused by *Fusarium oxysporum* f.sp. *cepae* is one of the most destructive diseases of onion, which cause serious yield losses in Japan, the Netherlands, and the USA (Sumner, 1995; Dıssanayake *et al*., 2009). In Turkey, Türkkan and Karaca (2006) found that Fusarium basal rot is a common and severe disease in Amasya province where onions are intensively cultivated. Fusarium basal rot is one of the most destructive diseases of onion, which cause serious yield loss. About 30-40% storage losses in onion occur due to incidence of Fusarium basal rot. The pathogen delayed seedling emergence and caused seedling damping-off as well as root and basal rot. The early symptoms of the disease in the field are curving, wilting, yellowing, and eventually dying back of the leaves from the tips. In addition, during very hot and dry conditions, diseased bulbs are discoloured, infected plants wilt and the infected tissue appears brown and watery when the bulbs are cut open (Sumner, 1995). Severely infected plants are easily removed from the soil when pulled, leaving the rotted basal plate and roots behind. Bulb rot can infect all plants in the Allium family (including leeks and chives) but garlic and onions are the most susceptible. Currently, there are no available resistant varieties. Onion crop suffers from basal rot (*Fusarium oxysporum*) and white rot (*Sclerotium rolfsii*) diseases causing various extents of losses (Entwistle, 1990).

The global pest, white rot, *Sclerotium cepivorum* is one of the serious fungal disease reducing potential yields of onion and garlic crops in Ethiopia to a considerable degree (Amin *et al*., 2014). Bulb rot spreads and overwinters as sclerotia. The sclerotia are highly resistant to adverse temperatures and conditions, and can remain alive in the soil for thirty or more years, even in the absence of a host. A very small number of sclerotia can cause significant disease, and it is very difficult to control. The first above-ground symptoms are a yellowing and dieback of the leaf tips, followed by a collapse of the affected leaves. A white, fluffy mold and soft rot will be observed. Masses of tiny black sclerotia can also be seen within this mold. Infected bulbs can rot in storage boxes and stain other bulbs. Bulb rot typically develops in patches in the field and is less of a problem when soils are warm and dry. The pathogen infects the basal stem plate of the onion bulb and degrades it, ultimately kills the whole plant (Cramer, 2000). The main sources of the inoculum are contaminated seeds and soil (Ozer and Koycu, 1997). Under field conditions, early disease symptoms are yellowing of leaves and tip dieback, and the whole plant may collapse with the development of the disease. If pathogen attacks the host plant late in the season, the symptoms may not appear until the onion bulbs are in storage (Ozer *et al*., 2003). The pathogenic fungi are soil-borne in nature; hence, seedling treatment and soil drenching by the chemicals may be beneficial in controlling the diseases. In an attempt to control the disease, farmers misapply synthetic pesticides such as champion, Bavistin DF, Folicur, Copper oxichloride, Copper + Metalaxyl etc. which have not been effective in controlling the disease (Awuah *et al.*, 2009). Bulb treatment and soil drenching require very low quantities of chemical materials compare to foliar application. Thus, it reduces the risk of environmental pollution, health hazard and not much costly to the growers. From the above facts, the present study was undertaken to find out the effective control measure of basal or bulb rot of Onion.

Materials and Methods

The experiment was conducted in sick plot at Spices Research Centre, BARI, Shibganj, Bogura, Bangladesh during Rabi season of 2017-18 The experimental plot was prepared with five ploughings and cross ploughings followed by laddering to break the clods as well as to level the soil. The weeds and stubbles of previous crops were collected and removed from the soil. Cowdung @5 t/ha, N @115kg/ha, P @55 kg/ha and K @75 kg/ha were applied. The entire quantity of cowdung, P, ¼ N and ¼ K were applied during final land preparation. The rest N and K were applied in three equal splits at 30, 50 and 70 days after planting (DAP) (Anonymous, 2017a). The experiment was carried out following Randomized Complete Block Design with three replications. Size of the unit plots was 2.0 m × 1.2 m and plant spacing was 30 cm × 20 cm. Bulb of BARI Piaz 4 was used in the experiment. The eight treatments were T_1= Healthy and fresh Bulb, T_2= Bulb treatment and soil drenching with Cabriotop (Pyraclostrobin 5% + Metiram 55% WG) @0.3%, T_3= Bulb treatment and soil drenching with Autostin (Carbendazim) @0.25%, T_4= Bulb treatment and soil drenching with Folicur 430 SC (Tebuconazole) @0.1%, T_5= Bulb treatment and soil drenching with Provax 200 WP (Carboxin + Thiram) @0.25%, T_6= Bulb treatment and soil drenching with Companion (Carbendazim + Mancozeb) @0.2%, T_7= Bulb treatment and soil drenching with Amistar Top 325 SC (Azoxystrobin + Difenoconazole) @0.1% and T_8= Control. Bulbs of onion were dipped in prepared fungicides solution for 30 minutes before planting and dried over night by air. Treated bulbs were planted on 14 November, 2017. Crop base at soil level was also sprayed with the fungicides 5 times at an interval of 7 days from seedling to flowering stage. Four weedings were done at 30, 50, 70 and 90 days after emergence and four irrigations were also applied just after each weeding. Other intercultural operations were done to maintain the normal hygienic condition of crop in the field. Rovral 50 WP (0.2%) was sprayed five times at an interval of 10 days to control purple blotch and stemphylium blight of onion. Admire (0.05%) was sprayed for controlling thrips. The plots were inspected regularly to take observations on bulb rot of the crop. Dead plants were counted in the field. Disease plant parts were collected in the laboratory for identifying causal pathogens of bulb rot. The crop was harvested from 5-9 April, 2018. Data on emergence of bulb, bulb rot, length of flower stalk, number of umbels per plant, number of capsules per umbel, number of capsules per plant, number of seeds per capsule, weight of seeds per plant and seed yield were recorded. The incidence of bulb rot of onion was recorded at every alternate day. The incidence of bulb rot of onion was calculated by the following formula:

$$\text{Incidence of bulb rot (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \text{ X } 100$$

The recorded data were analyzed statistically to find out the level of significance and the variations among the respective data were compared following Duncan's Multiple Range Test for interpretation of the results (Gomez and Gomez, 1984).

Results and Discussion

Effect of Fungicides on Percent Emergence and Bulb Rot of Onion

Results on effect of fungicides on percent emergence and bulb rot incidence of onion are presented in Table 1. Emergence and bulb rot incidence were significantly influenced by the treatments. Emergence of onion seedlings under different treatments ranged from 86.92 - 98.11%, while the lowest emergence was recorded in control plots which was statistically similar to Healthy and fresh bulb (88.41%), and the highest emergence was recorded in Bulb treatment and soil drenching with Amistar Top 325 SC which was followed by Bulb treatment and soil drenching with Cabriotop (96.33%) and Bulb treatment and soil drenching with Provax 200 WP (94.42%). The lowest bulb rot incidence (8.76%) and the highest disease reduction over control (70.52%) was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC which was statistically dissimilar to all other treatments. The highest bulb rot incidence (29.72%) was obtained from untreated control which was followed by Healthy and fresh Bulb (25.59%).

Effect of Fungicides on Length of Flower Stalk, Number of Umbels Per Plant, Number of Capsules Per Umbel and Number of Capsules Per Plant of Onion

Results on effect of fungicides on length of flower stalk, number of umbels per plant, number of capsules per umbel and number of capsules per plant of onion are presented in Table 2. Treatments showed significant variation on length of flower stalk, number of umbels per plant, number of capsules per umbel and number of capsules per plant of onion. The tallest flower stalk (96.86 cm) was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) which was statistically similar to Bulb treatment and soil drenching with Cabriotop (0.3%) and Bulb treatment and soil drenching with Provax 200 WP (0.25%), and the lowest (89.55 cm) was obtained from Control. Number of umbels per plant ranged from 3.00 to 4.46, while the highest number of umbel per plant was observed in Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) which was followed by Bulb treatment and soil drenching with Cabriotop (0.3%) and Bulb treatment and soil drenching with Provax 200 WP (0.25%), and the lowest number of umbels per plant was observed in untreated control. Bulb treatment and soil drenching with Amistar Top 325 SC gave the highest number of capsules per umbel (100.46) which was followed by Bulb treatment and soil drenching with Cabriotop (99.60), and the lowest number of capsules per umbel (81.33) was observed in control treatment. Number of capsules per plant ranged from 265.55 to 448.05, while the highest number of capsules per plant was observed in Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) which was followed by Bulb treatment and soil drenching with Cabriotop (0.3%) and Bulb treatment and soil drenching with Provax 200 WP (0.25%), and the lowest number of capsules per plant was observed in untreated control.

Table 1: Effect of fungicides on percent emergence and bulb rot of onion

Fungicides	**Emergence (%)**	**Bulb rot (%)**	**Disease reduction over control (%)**
T_1= Healthy and fresh Bulb	88.41 ef	25.59 b	13.89
T_2= Bulb treatment and soil drenching with Cabriotop (0.3%)	96.33 ab	11.37 g	61.74
T_3= Bulb treatment and soil drenching with Autostin (0.25%)	90.50 de	20.85 c	29.84
T_4= Bulb treatment and soil drenching with Folicur 430 SC (0.1%)	92.67 cd	15.86 e	46.63
T_5= Bulb treatment and soil drenching with Provax 200 WP (0.25%)	94.42 bc	13.67 f	54.01
T_6= Bulb treatment and soil drenching with Companion (0.2%)	91.08 cde	18.58 d	37.48
T_7= Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%)	98.11 a	8.76 h	70.52
T_8= Control	86.92 f	29.72 a	-
CV (%)	7.56	6.92	-

Similar letter(s) did not differ significantly at 1% level of probability.

Table 2: Effect of fungicides on length of flower stalk, number of umbels per plant, number of capsules per umbel and number of capsules per plant of onion

Fungicides	Length of flower stalk (cm)	No. of umbels/ plant	No. of capsules/ umbel	No. of capsules/plant
T_1= Healthy and fresh Bulb	90.00 cd	3.20 de	88.27 f	282.24 f
T_2= Bulb treatment and soil drenching with Cabriotop (0.3%)	94.13 ab	4.00 ab	99.60 ab	398.40 b
T_3= Bulb treatment and soil drenching with Autostin (0.25%)	90.41 bcd	3.33 cde	90.11 ef	300.06 e
T_4= Bulb treatment and soil drenching with Folicur 430 SC (0.1%)	92.11 bcd	3.80 bc	94.15 cd	357.77 c
T_5= Bulb treatment and soil drenching with Provax 200 WP (0.25%)	93.66 abc	3.82 bc	96.65 bc	340.21 d
T_6= Bulb treatment and soil drenching with Companion (0.2%)	91.54 bcd	3.63 bcd	91.88 de	333.52 d
T_7= Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%)	96.86 a	4.46 a	100.46 a	448.05 a
T_8= Control	89.55 d	3.00 e	81.33 g	265.55 g
CV (%)	8.46	6.72	7.03	6.89

Similar letter(s) did not differ significantly at 1% level of probability.

Table 3: Effect of fungicides on seed yield and seed attributes of onion

Fungicides	No. of seeds/ capsule	Wt. of seeds/ plant	Seed yield (kg/ha)
T_1= Healthy and fresh Bulb	4.15	5.36 b	578.67 g
T_2= Bulb treatment and soil drenching with Cabriotop (0.3%)	4.63	6.07 ab	739.78 b
T_3= Bulb treatment and soil drenching with Autostin (0.25%)	4.18	5.55 ab	600.11 f
T_4= Bulb treatment and soil drenching with Folicur430 SC (0.1%)	4.50	5.94 ab	691.55 d
T_5= Bulb treatment and soil drenching with Provax 200 WP (0.25%)	4.46	5.98 ab	710.95 c
T_6= Bulb treatment and soil drenching with Companion (0.2%)	4.20	5.77 ab	668.27 e
T_7= Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%)	4.73	6.18 a	750.56 a
T_8= Control	4.00	3.95 c	490.33 h
CV (%)	NS	6.23	7.42

Similar letter(s) did not differ significantly at 1% level of probability.
NS=Not Significant

Effect of Fungicides on Seed Yield and Seed Attributes of Onion

Results on effect of fungicides on seed yield and seed attributes of onion are presented in Table 3. Treatment had significant effect on weight of seeds per plant and seed yield of onion. Though the number of seeds per capsule was not significant, but number of seeds per capsule ranged from 4.00 to 4.73, while the highest number of seeds per capsule was recorded in Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) and the lowest number of seeds per capsule was recorded in untreated control plot. The highest seed yield per plant (6.18 g) was weighed in Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) and the lowest (3.95 g) seed yield per plant was weighed in untreated control which was statistically dissimilar to other treatments. Significantly the highest seed yield (750.56 kg/ha) was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC which was followed by Bulb treatment and soil drenching with Cabriotop (739.78 kg/ha) and Bulb treatment and soil drenching with Provax 200 WP (710.95 kg/ha), but Control treatment gave the lowest seed yield (490.33 kg/ha) which was followed by Healthy and fresh Bulb (578.67 kg/ha) treatment.

It has been revealed that emergence and bulb rot incidence of onion were significantly influenced by the treatments. The lowest emergence was recorded in control plots which was statistically similar to Healthy and fresh bulb, and the highest emergence was recorded in Bulb treatment and soil drenching with Amistar Top 325 SC which was followed by Bulb treatment and soil drenching with Cabriotop and Bulb treatment and soil drenching with Provax 200 WP. The lowest bulb rot incidence and the highest disease reduction over control was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC which was statistically dissimilar to all other treatments. The highest bulb rot incidence was obtained from untreated control which was followed by Healthy and fresh Bulb. Sintahehu *et al.* (2011) dipped Shallot (*Allium cepa* var. *aggregatum*) bulbs in prochloraz, tebuconazole, carbendazim, mancozeb for bulb treatment and found that Prochloraz and carbendazim reduced Fusarium basal rot incidence (40 & 43%). Yadav *et al*. (2017) reported that difenoconazole 25 EC inhibit 88.93% of colony growth of *Alternaria porri* and *Stemphylium vesicarium* and effective to manage purple blotch complex of onion. Like azoxystrobin, difenoconazole was reported highly effective for controlling powdery mildew of mango (97.9% over control) when compared with other conventional fungicides (Raj and Badiyala, 2000). Capriotti *et al.* (2005) reported that Cabriotop, active ingredient pyraclostrobin + metiram (5 + 55% WG) was highly effective to control downy mildew of grapevine and tomato fungal diseases. Cabriotop had an outstanding preventive activity and it strongly inhibits conidia germination. Both its prompt absorption by plant tissues and its high trans-laminar redistribution allowed a thorough canopy protection. Provax 200 WP (0.2%)/Knowin or Bavistin DF (0.2%) controlled bulb rot of Onion with five times spraying at an interval 7-10 days at the base of onion plant including soil (Anonymous, 2017b). El-Naggar *et al*. (2018) showed that *Aspergillus niger*, *Alternaria tenius*, *Rhizoctonia solani*, *Fusarium semitectium* and *Fusarium moniliforme* were found to be control by the fungicide Vitvax (i.e. Provax) compared to check treatments. The percentage of post emergence damping-off caused by the tested fungi was decreased in response to the effect of Vitvax (i.e. Provax).

Treatments showed significant variation on length of flower stalk, number of umbels per plant, number of capsules per umbel and number of capsules per plant of onion. The tallest flower stalk was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) which was statistically similar to Bulb treatment and soil drenching with Cabriotop (0.3%) and Bulb treatment and soil drenching with Provax 200 WP (0.25%), and the lowest was obtained from Control. The highest number of umbel per plant was observed in Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) which was followed by Bulb treatment and soil drenching with Cabriotop (0.3%) and Bulb treatment and soil drenching with Provax 200 WP (0.25%), and the lowest number of umbels per plant was observed in untreated control. Bulb treatment and soil drenching with Amistar Top 325 SC gave the highest number of capsules per umbel which was followed by Bulb treatment and soil drenching with Cabriotop, and the lowest number of capsules per umbel was observed in control treatment. The highest number of capsules per plant was observed in Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) which was followed by Bulb treatment and soil drenching with Cabriotop (0.3%) and Bulb treatment and soil drenching with Provax 200 WP (0.25%), and the lowest number of capsules per plant was observed in untreated control.

Treatment had significant effect on weight of seeds per plant and seed yield of onion. Though the number of seeds per capsule was not significant, while the highest number of seeds per capsule was recorded in Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) and the lowest number of seeds per capsule was recorded in untreated control plot. The highest seed yield per plant was weighed in Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) and the lowest seed yield per plant was weighed in untreated control which was statistically dissimilar to other treatments. Significantly the highest seed yield was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC which was followed by Bulb treatment and soil drenching with Cabriotop and Bulb treatment and soil drenching with Provax 200 WP, but Control treatment gave the lowest seed yield which was followed by Healthy and fresh Bulb treatment. Sintahehu *et al.* (2011) dipped Shallot (*Allium cepa* var. *aggregatum*) bulbs in prochloraz, tebuconazole, carbendazim, mancozeb for bulb treatment and found that Prochloraz and carbendazim increased yield (42-45%). Craven *et al.* (2017) reported that Azoxystrobin/difenoconazole application significantly increased yield of sorghum increase of 33.6% compared to the control.

Conclusion

Among the fungicides, Amistar Top 325 SC (0.1%) and Cabriotop (0.3%) and Provax 200 WP (0.25%) were found individually more effective to control basal or bulb rot of onion, enhance growth attributes and yield. So, farmers and researchers may use Amistar Top 325 SC or Cabriotop or Provax 200 WP to decrease bulb rot incidence and increase seed yield of Onion.

Conflict of Interest

The authors declare that there is no conflict of interest with present publication.

References

Ahmed MU and Hossain MM (1985) Final report of the project crop diseases, survey and establishment of herbarium at BARI. Plant Pathology Div. BARI, Gazipur. p. 170.

Amin M, Tadele S and Selvaraj T (2014) White rot (*Sclerotium cepivorum* Berk)-an aggressive of onion and garlic in Ethiopia: An overview. *Journal of Agricultural Biotechnology and Sustainable Development* **6**(1): 6-15.

Anonymous (2017a) Krishi Projukti Hatboi (Handbook on Agro-technology), 7th edition. Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh. pp. 276-277.

Anonymous (2017b) Krishi Projukti Hatboi (Handbook on Agro-technology), 7th edition. Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh. p. 284.

Awuah RT, Kwoseh C, Kuranteng SL, Okpala ROC and Amoako-Attah I (2009). Appearance of *Fusarium* Basal Rot

Disease of Onion in the Kwahu Sought District of Ghana. Ghana *Journal of Horticulture* **7**: 84-88.

Capriotti M, Marchi A, Coatti M and Manaresi M (2005) A broad spectrum fungicide for the control of the main grapevine and tomato diseases [*Vitis vinifera* L.; *Lycopersicon esculentum* Mill.; Italy]. AGRIS, FAO.

Cramer CS (2000) Breeding and genetics of Fusarium basal rot resistance in onion. *Euphytica* **115:** 159-166.

Craven M, Smith K, Berner J, Morey L and Mclaren N (2017) Evaluation of fungicides for potential growth regulating properties on sorghum. *Crop Protection* **101:** 43-49.

Dıssanayake MLMC, Kashıma R, Tanaka S and Ito SI (2009) Genetic diversity and pathogenicity of *Fusarium oxysporum* isolated from wilted Welsh onion in Japan. *Journal of General Plant Pathology* **75**: 125–130.

El-Naggar MAA, Zaki MF and El-Shawadfy MA (2018) Management of onion root-rot diseases caused by soil born fungi under Middle Sinai conditions. *Middle East Journal of Applied Sciences* **8**(1): 91-99.

Entwistle AR (1990) Root Diseases. In Onions and Allied Crops Vol. II Eds. H.D. Rabinowitch and J.L. Brewster, CRC Press Inc. Florida, 103-154.

Gomez KA and Gomez AA (1984) Statistical Procedures for Agricultural Research. 2nd ed., Intl. Rice Res. Inst., John Willy and Sons, New York, Chichester, Brisbane, Toronto, Singapore. pp. 187-240.

Kukanoor L (2005) Post–harvest studies in onion Cv. N-53. Ph.D. Thesis. Department of Horticulture. College of Agriculture. The University of Agricultural Sciences, Dharwad, Karnataka, India.

Meah and Khan AA (1987) Checklist of vegetables and fruit disease in Bangladesh. Dept. of Plant pathology, Bangladesh Agricultural University, Mymensingh. p. 22.

Munoz DCL, Martinez, JJP and Perez AP (1984) Onion seed production under tropical conditions. Humbaldt Inst. Fund. *Res. Trop. Agric. Acad. Sci*. **10**(2): 42-45.

Özer N and Köycü ND (1997) The pathogenicity of Aspergillus niger and some Fusarium species on onion seeds and seedlings. Proceedings of the 10th Congress of the Mediterranean Phytopathological Union, Montpellier, 277- 281.

Özer N, Köycü D, Chilosi G, Pizzuolo PH, Coşkuntuna A and Magro P (2003) Pectolytic isoenzymes by *Fusarium oxysporum* f. sp. *cepae* and antifungal compounds in onion cultivars as a response to pathogen infection. *Canadian Journal of Plant Pathology* **25**: 249-257.

Ozer N, Koycu ND, Choilosi G and Margo P (2004) Resistance to Fusarium basal rot in greenhouse and field and association expression of antifungal compounds. *Phytoparasitica* **32:** 388-394.

Raj H and Badiyala SD (2000) Field evaluation of some new fungicides for the control of powdery mildew (*Oidium mangiferae*) of mango (*Mangifera indica*). *Ind. J. Agric. Scim.* **70**: 420-421.

Sintayehu A, Sakhuja PK, Chemeda Fininsa and Seid Ahmed (2011) Management of Fusarium basal rot (Fusarium oxysporum f.sp. cepae) on shallot through fungicidal bulb treatment. Crop Protection 30(5): 560-565.

Sumner DR (1995) *Fusarium* Basal Rot. American Phytopathological Society. p. 10-11.

Türkkan M and Karaca G (2006) Determination of fungal root rot disease agents associated with onion fields in Amasya province. *Journal of Agricultural Sciences* **12**: 357–363.

Yadav RK, Singh A, Jain S and Dhatt AS (2017) Management of Purple Blotch Complex of Onion in Indian Punjab. *Int. J. Appl. Sci. Biotechnol.* **5**(4): 454-465.