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Management of Downy Mildew of Onion Through Selective Fungicides in the Field Condition

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Abstract

Efficacy of various fungicides against powdery mildew of onion all chemical treated 1st, 2nd, 3rd and 4th observation Score observation in plants (out of 15) were 0.97, 2.89, 2.44 and 2.22 against 2.33, 9.00, 10.00 and 10.33 in control; disease infection 6.47, 20.00, 16.30 and 14.07% against 15.56, 60.00, 66.67 and 68.89% in control; infected leaves/plant 0.20, 2.04, 2.38 and 2.02 against 1.04, 4.36, 4.99 and 4.04 leaves in control, respectively. The Cabriotop observation resulted in infected plants 1.00, 2.56, 1.89 and 1.67 against 2.32, 9.00, 10.00 and 10.33 in control; disease infection 6.67, 17.04, 12.59 and 11.11 against 15.56, 60.00, 66.67 and 68.89% in control, infected leaves 0.41, 2.22, 2.62 and 2.07 against 1.04, 4.36, 4.99 and 4.04 in control, respectively with average bulb weight of 126.50g.The Relly observation in infected plants 0.96, 3.33, 2.78 and 3.11 against 2.33, 9.00, 10.00 and 10.33 in control; disease infection 6.42, 22.22, 18.52 and 20.74% against 15.56, 60.00, 66.67 and 68.89% in control; infected leaves 0.41, 2.22, 2.62 and 2.07 against 1.04, 4.36, 4.99 and 4.04 in control, respectively with average bulb weight of 116.38g against 74.34g in control. Defer plus at observation resulted in infected plants of 0.95, 2.78, 2.56 and 2.78 against 2.33, 9.00, 10.00 and 10.33 in control; disease infection 6.33, 18.52, 17.04 and 18.52% against 15.56, 60.00, 66.67 and 68.89% in control; infected leaves 0.50, 2.10, 2.48 and 1.96 against 1.04, 4.36, 4.99 and 4.04/plant in control; with average bulb weight of 101.63g, 106.97g and 112.61g overall average bulb weight of 107.07g against 74.34g bulb weight on average in control

Keywoeds: Downy Mildew, Fungicides, Management, Onion

Introduction

Onion (*Allium cepa* L.) is an essential item of food preparation in our daily diet. Onion is a thermal and photosensitive crop. In Pakistan, it is mainly produced in winter season. Onion cultivation during summer season is constrained due to adverse weather along with absence of summer tolerant varieties and proper cultural practices. In Pakistan, the onion is cultivated in almost all parts of the country. The area under onion cultivation in the country during 2015-2016 was 130.6 thousand hectares with a production of 1674.6 thousand tons; while during the year 2014-2015, the area under onion cultivation in the country was 130.5 thousand hectares with the production of 1671.0 thousand tons. This indicates 0.2 percent increase in the production during 2015-2016 as compared to the onion production during 2014-2015 (GOP, 2016). The onion crop is infected by many diseases. Among those diseases, downy mildew of onion, caused by the fungus *Peronospora destructor*, is worldwide in occurrence and causes devastating economic losses to the crop (Cook, 2015; Viranyi, 2015). The pathogen attacks various kinds of onion but is especially destructive to the common onion, i.e. *Allium cepa*. If leaf damage is severe, bulb development is markedly retarded and as a result, a large number of "bottlenecked" onion bulbs develop (Rondomanski, 2013, Butler and Jones 2013) reported that the disease attacks the plants at all stages of growth and all parts of the plant may be invaded. The disease occurs in two stages the primary stage when an infected bulb is planted and the second stage when a healthy plant

at leaf stage becomes infected from spores produced by primary stage. Downy mildew *Peronospora destructor* and purple blotch *Alternaria porr)* are among the most important diseases of onion, often causing total crop losses in favourable weather (Makelo, 2013; Jayakumar *et al*., 2008) the diseases are primarily managed by application of chemical fungicides. Measures to reduce sources of infection and prevent spread of disease are of great importance in controlling onion during mildew. Elimination of infected plants, heat treatment of bulbs and eradication of diseased volunteer plants are recommended for the control of the disease. However, currently, the most effective means to control downy mildew is the use of fungicides. However, the success of chemical control mainly depends on high frequency of spraying (Kucharek, 2013). These fungicides either inhibit germination, growth or multiplication of the pathogen (Agrios, 1997). Mohibullah (1992) used several fungicides (Antracol, Cuprisan 311-Super D, Dithane M-45, Nemispor, Penncozeb, Sandofan M, Ridomil MZ-71 and TriMiltox Forte) against downy mildew of onion. Highly significant control of the disease was obtained with Ridomil MZ-71 WP and Sandofan M followed by Nemispor. Tahir et al. (1990) applied eight fungicides, i.e. Antracol 70 WP, Liromanzeb 80 WP, Daconil 75 WP, Ridomil MZ-72 WP, Duter-WP, Polyram Combi, Tri-Miltox Forte and Cupravit. Among these, Antracol 70 WP was the most effective, followed by Ridomil MZ-72 WP. These fungicides increased bulb yield by 8-52% over the control. Testing of the available fungicides is essential for selecting the most effective and costeffective ones. In addition, increased frequency of chemical application leads to development of pathogen resistant strains and accumulation of residues in produce and environment resulting in risks to health, environment and non-target organisms (Burkett-Cadena *et al*., 2008). These concerns have led to regulation in the use of agrochemical thus providing an impetus to the search for alternative sustainable strategies. The efficiency of protection means depends on their application time and disease development level. The current IPM recommendation is to apply fungicides at the first sign of downy mildew (Wright *et al*., 2002). Generally, preventive fungicide sprays are scheduled 7–10 days apart to control downy mildew and to ensure good yields and high crop quality (Palti, 1989). On the other hand, fungicide applications undertaken during unfavourable weather conditions for infection and disease spread are economically and ecologically superfluous. Therefore effective plant protection means are in great demand (Sodo ir darzo, 2007). Muhammad *et al.* (2015) reported that fungicides decreased severity of powdery mildew disease markedly (from 72.66 to 91.66%) and improved onion bulb yield from 88 to 181.81 percent over control. Melody Duo 66.8 WP gave the best result among all the fungicides which reduced the disease severity 91.66 percent. Lepse *et al.* (2013) used different fungicides against *P. destructor* and the efficacy of these fungicides fluctuated between 6-91%. Whiteman and Beresford (2013) reported that fungicide efficacy is mainly linked with the application timing for downy mildew control and climatic conditions. Fazli *et al.* (2012) tested Aliette, Antracol, Benlate, Cobox, Daconil, Derosal, Dithane, Polyram, Ridomil and Topsin-M for evaluation of their efficacies against onion downy mildew caused by *Peronospora destructor*. The fungicide Ridomil remained most effective to reducing disease severity and increased yield of onion. Raziq *et al.* (2008) tested Aliette, Antracol, Benlate, Cobox, Daconil, Derosal, Dithane, Polyram, Ridomil and Topsin-M fungicides against onion mildew disease and reported that all fungicides were effective to control the disease. However, Ridomil showed highest efficacy against the disease. Tahir *et al.* (1990) reported that minimum disease severity was recorded in Ridomil treated plots (13.13 %) followed by Topsin-M (20.00 %) and Aliette (22.50 %), while maximum disease severity (68.75 %) was observed in the untreated plot. Khokhar and Jaffrey (2000) examined the efficacy of Ridomil MZ 72 WP, Antracol 70 WPM, Liromanzeb 80 Dithane M 45 WP, Polyram Combi and Cupravit fungicides against downy mildew disease of onion; and found that Ridomil MZ 72 WP was highly effective against the target disease followed by Antracol 70 WP, Liromanzeb 80 Wp and others. Elena *et al.* (2008) reported that 03 sprays of fungicides suppressed downy mildew incidence significantly and efficacy averaged 74.38–89.36% and increased the marketable onion yield by 4.3–26.3%.In the present study, several fungicides were evaluated under field conditions to find effective and economical fungicides for the control of this important disease.

Materials and Methods

The experiment in order to conduct the present research was laid out in the agricultural

fields of Iqbal Ahmed Qureshi Agriculture Farm, Tando Muhammad Khan, 2017in a three replicated randomized complete block design (RCBD). For an experiment, an area of ¼ acre was achieved and seedbed preparation was done. About one and half month before the commencement of onion season, the onion nursery was sown at the seed rate of 8 kg per acre. Meanwhile, the land preparation was initiated, until the onion nursery was developed. The land was prepared by one dry ploughing followed by clod crushing and leveling to achieve a good seedbed with uniform distribution of irrigation water. The soaking dose of irrigation water was applied before sowing. Ridges having width of 75 cm were prepared. Four treatments including control with three replications for each treatment were used. The plot size used for each treatment in all three replications was 10m × 10m keeping row to row distance of 75 cm and plant to plant space of 30 cm. A good seedbed was prepared and a total of 45 plots were prepared. Fifteen (15) plants were allocated to each replication; and in each of five treatments, each fungicide was applied at three different doses. For sowing, the nursery of commercial variety 'Phulkara' was obtained and transplanted on both sides of the ridges. The experimental area was kept clean of weeds and fertilizers were applied as per the recommended rates. The irrigation water was also applied at weekly interval. On occurrence of downy mildew, the experimental crop was sprayed with the following fungicides:

Treatments (Fungicides)

T_1= Score (@ concentration of 1,2 and 3 ml/lit water)

T_2 = Cabriotop (@ concentration of 0.5,1 and 2 mg/lit water)

T_3 = Relly (@ concentration of 0.5,1 and 2 mg/lit water)

T_4 = Defer plus (@ concentration of 0.5,1 and 2 mg/lit water)

T_5 = Control (untreated)

The fungicide solution was prepared by mixing the powder of each fungicide at the rates/concentrations given above against the name of each fungicide. The solution was sprayed on the standing onion crop using knapsack hand sprayer. After a spray of one fungicide, the spray tank was thoroughly washed to avoid any residual effect of previously used fungicide when next fungicide is being sprayed.

Survey and Sampling collection: The leaf samples showing typical symptoms of downy mildew were collected from Iqbal Ahmed Qureshi Form, Tando Muhammad Khan and were brought for isolation and identification to a laboratory of Plant Pathology, Department, Faculty of Crop Protection Sindh Agriculture University, Tandojam.

Isolation and identification: The isolation and identification of obtained fungi were done through morphological characteristics of fungi and with the help of keys. Furthermore, *in-vivo* studies of some selective fungicide against the reported pathogen were conducted on Downy mildew of onion. After spray of the fungicides, the onion experimental crop was examined for the following parameters:

Parameters studied

1. Length of leaves (cm)
2. Number of infected plants (out of 15 plants)
3. Infection percentage
4. Number of leaves plant^{-1}
5. Number of infected leaves plant^{-1}
6. Average bulb weight (g)

Statistical Analysis: The data was recorded by selecting 4 plants in each treatment. The result for achieved were analyzed through computer, using student edition of "Statistix" to find out the significance of efficacy between different fungicides.

Results

The study on the management of downy mildew of onion through selective fungicides was carried out during the year 2017, at Iqbal Ahmed Qureshi Agriculture Farm, Tando Muhammad Khan.Four fungicides were included in the treatment plan and a control was kept to compare the efficacy of the fungicides. Each fungicide was applied at different concentrations to determine the most appropriate concentration. The treatments included: T_1= Score (@ concentration of 1,2 and 3 ml/lit water), T_2 = Cabriotop (@ concentration of 0.5,1 and 2 mg/lit water); T_3 = Relly (@ concentration of 0.5,1 and 2 mg/lit water); T_4 = Defer plus (@ concentration of 0.5,1 and 2 mg/lit water); T_5 = Control (untreated). The treatment effect was analysed on the basis of length of leaves (cm), number of infected plants (out of 15 plants), infection percentage, number of leaves plant^{-1}, number of infected leaves plant^{-1}, average bulb weight (g) and the data on these parameters are given in Tables 1-6. The average treatment effect is illustrated in graphs (Figure 1-6). The results of the study on the above parameters are presented under respective sub-

headings followed by relative interpretation in this chapter.

Length of leaves (cm)

Score: Most of the concentrations of this fungicide were effective against onion downy onion leaves; while minimum length of leaves (31.58 cm) was recorded in plots sprayed with Score @ 1 ml/L concentration. The average length of onion leaves at 1st, 2nd, 3rd and 4th observation was 31.27, 31.74, 32.21 and 32.70 cm, against 26.95, 27.22, 27.49 and 27.77 cm in control, respectively. The length of onion leaves showed similarity (P>0.05) when Score was applied at 1 ml/L and 2 ml/L concentrations; while significant (P<0.05) when compared with 3 ml/L concentration (Table 1).

Cabriotop: All the concentrations of fungicide Cabriotop significantly improved the length of onion leaves as compared to untreated (control); however, higher concentrations were more effective than lower ones to improve length of onion leaves. The average length of onion leaves in crop sprayed with Cabriotop at 0.5 mg/L, 1.0 mg/L and 2.0mg/L was 32.73, 33.0 and 33.70 cm, respectively. The average length of onion leaves at 1st, 2nd, 3rd and 4th observation was 32.20, 32.69, 33.34 and 34.34 cm, against 26.95, 27.22, 27.49 and 27.77 cm in control, respectively. The length of onion leaves showed similarity (P>0.05) when Score was applied at 1 ml/L and 2 ml/L concentrations; while significant (P<0.05) when compared with 3 ml/L concentration (Table 1).

Relly: In mostcases, the fungicide Relly worked effectively against onion downy mildew *Peronospora destructor* and average length of onion leaves sprayed with Relly at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 31.32, 31.58 and 32.25 cm, respectively. The average length of Relly sprayed onion leaves at 1st, 2nd, 3rd and 4th observation was 31.01, 31.48, 31.95 and 32.43 cm, against 26.95, 27.22, 27.49 and 27.77 cm in control, respectively (Table 1).

Defer plus: The impact of Defer plus on length of leaves was relatively lower than Cabriotop, Score and Relly but yet was effective as compared to control. The average length of onion leaves sprayed with Defer plus at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 30.90, 31.15 and 31.82 cm, respectively. The average length of Defer plus sprayed onion leaves at 1st, 2nd, 3rd and 4th observation was 30.59, 31.05, 31.52 and 31.99 cm against 26.95, 27.22, 27.49 and 27.77 cm in control, respectively (Table 1).

Table 1: Length of leaves (cm) as affected by different fungicides and concentration levels

Treatments	Dose	Observations				Average
		First	Second	Third	Fourth	
T_1= Score	1ml/L	30.88	31.34	31.81	32.29	31.58 **B**
	2ml/L	31.14	31.60	32.08	32.56	31.85 **B**
	3ml/L	31.79	32.27	32.75	33.25	32.52 **A**
Average		**31.27 B**	**31.74 B**	**32.21 B**	**32.70 B**	-
T_2 = Cabriotop	0.5mg/L	31.80	32.28	32.92	33.91	32.73 **B**
	1mg/L	32.07	32.55	33.20	34.19	33.00 **B**
	2mg/L	32.74	33.23	33.90	34.92	33.70 **A**
Average		**32.20 A**	**32.69 A**	**33.34 A**	**34.34 A**	-
T_3 = Relly	0.5mg/L	30.62	31.08	31.55	32.02	31.32 **B**
	1mg/L	30.88	31.34	31.81	32.29	31.58 **B**
	2mg/L	31.53	32.00	32.48	32.97	32.25 **A**
Average		**31.01 B**	**31.48 B**	**31.95 B**	**32.43 B**	-
T_4 = Defer plus	0.5mg/L	30.21	30.66	31.12	31.59	30.90 **B**
	1mg/L	30.46	30.92	31.38	31.85	31.15 **B**
	2mg/L	31.11	31.57	32.05	32.53	31.82 **A**
Average		**30.59 C**	**31.05 C**	**31.52 C**	**31.99 C**	-
T_5 = Control		26.95 D	27.22 D	27.49 D	27.77 D	-
S.E.±		0.1688	0.1709	0.1740	0.1772	-
LSD 0.05		0.3458	0.3501	0.3564	0.3627	-
P-Value		0.0000	0.0000	0.0000	0.0000	-

It was observed that the length of leaves was highest in plots sprayed with highest dose of fungicides regardless of fungicide products. Hence, it is suggested that for effective control of onion downy mildew, the crop may be sprayed with Cabriotop, Relly and Defer plus at 2 mg/L; while effective concentration for fungicide Score was 3ml/L. However, on the basis of overall performance related to leaves length, Cabriotop at 2mg/L concentration may preferably be applied on onion against downy mildew.

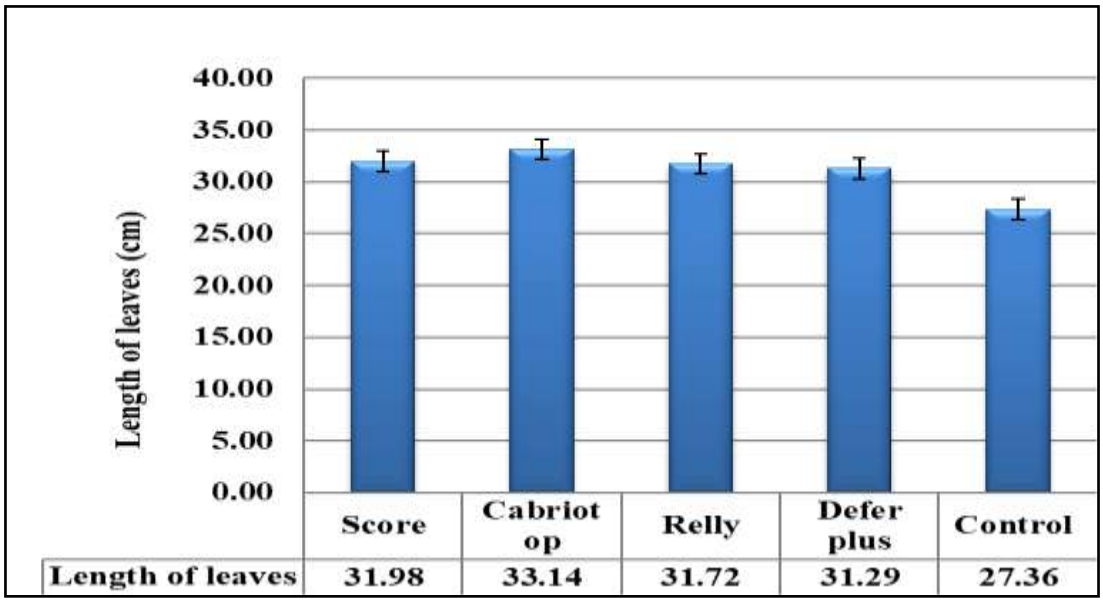

Fig. 1: Length of leaves (cm) as affected by different fungicides

Overall fungicidal effects on length of leaves: Theoverall average length of onion leaves as affected by fungicidal treatment against onion downy mildew was significantly higher (33.14 cm) in Cabriotop sprayed crop, while similarity in length of leaves was recorded in plots sprayed with Score (31.98 cm), Relly (31.72 cm) and Defer plus (31.29 cm). However, length of leaves decreased considerably ($P<0.05$) in control plots (27.36 cm); where no fungicides were sprayed (Fig-1). This indicates that Cabriotop was more effective against onion downy mildew as compared to rest of the fungicides; while Score, Relly and Defer plus were almost equal in efficacy against downy mildew as reflected by the onion length of leaves.

Number of infected plants (out of 15 plants): Score: The onion plantation sprayed with Score indicated that higher concentrations of this fungicide were more effective against onion downy mildew, *Peronospora destructor*. The infected plants were minimum (1.66) at 3ml/L concentration, followed by 2 ml/L concentration (2.08); while maximum infected plants (2.66) were recorded in plots sprayed with Score @ 1 ml/L concentration. The average infected plants at 1st, 2nd, 3rd and 4th observation in plots sprayed by Score was 0.97, 2.89, 2.44 and 2.22 against 2.33, 9.00, 10.00 and 10.33 plants in control, respectively. The number of infected plants showed similarity ($P>0.05$ under fungicide application at 1ml/L and 2ml/L concentrations; while significant ($P<0.05$) when compared with 3 ml/L concentration (Table 2).

Cabriotop: The application offungicide Cabriotop decreased the number of infected plants more than other fungicides over control regardless of their concentration; however, number of infected plants decreased with increasing fungicide concentration. The average number of infected plants in crop sprayed with Cabriotop at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 2.25, 1.84 and 1.25, respectively. Out of 15 examined leaves, at 1st, 2nd, 3rd and 4th observation, the average infected plants were 1.00, 2.56, 1.89 and 1.67, against 2.32, 9.00, 10.00 and 10.33infected plants in control, respectively. The infected plants were almost similar ($P>0.05$) when Cabriotop was applied at 0.5mg/L and 1.0mg/L concentrations; while significant ($P<0.05$) when compared with 2mg/L concentration (Table 2).

Relly: Against onion downy mildew (*Peronospora destructor*), fungicide Relly in mostcases showed positive impact on onion crop and decreased the number of infected plants over respectively. The average number of infected plants in Relly sprayed plantation at 1st, 2nd, 3rd and 4th observation was 0.96, 3.33, 2.78 and 3.11, against 2.33, 9.00, 10.00 and 10.33infected plants in control, respectively (Table 2).

Defer plus: Sprayingfungicide Defer plus at different doses showed positive impact on onion plantation by decreasing onion downy mildew infected plants as compared to control. The control.The average infected plants in plots sprayed by fungicide Relly at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 3.07, 2.49 and 2.08,

average number of infected onion plants in plots sprayed with Defer plus at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 2.65, 2.32 and 1.82, respectively. The average number of infected plants in Defer plus sprayed plots at 1st, 2nd, 3rd and 4th observation was 0.95, 2.78, 2.56 and 2.78 against2.33, 9.00, 10.00 and 10.33infected plants in control, respectively (Table 2).

Table 2: Number of infected plants (out of 15 plants) as affected by different fungicides and their concentrations

Treatments	Dose	Observations				Average
		First	Second	Third	Fourth	
T_1= Score	1ml/L	1.29	3.67	3.00	2.67	2.66 **A**
	2ml/L	0.97	3.00	2.33	2.00	2.08 **A**
	3ml/L	0.65	2.00	2.00	2.00	1.66 **B**
Average		**0.97 B**	**2.89 B**	**2.44 BC**	**2.22 CD**	-
T_2 = Cabriotop	0.5mg/L	1.33	3.33	2.33	2.00	2.25 **A**
	1mg/L	1.00	2.67	2.00	1.67	1.84 **A**
	2mg/L	0.67	1.67	1.33	1.33	1.25 **B**
Average		**1.00 B**	**2.56 B**	**1.89 C**	**1.67 D**	-
T_3 = Relly	0.5mg/L	1.28	4.00	3.33	3.67	3.07 **A**
	1mg/L	0.96	3.33	2.67	3.00	2.49 **A**
	2mg/L	0.64	2.67	2.33	2.67	2.08 **B**
Average		**0.96 B**	**3.33 B**	**2.78 B**	**3.11 B**	-
T_4 = Defer plus	0.5mg/L	1.27	3.00	3.00	3.33	2.65 **A**
	1mg/L	0.95	3.00	2.67	2.67	2.32 **A**
	2mg/L	0.63	2.33	2.00	2.33	1.82 **B**
Average		**0.95 B**	**2.78 B**	**2.56 BC**	**2.78 BC**	**-**
T_5 = Control		2.33 A	9.00 A	10.00 A	10.33 A	**-**
S.E.±		0.1898	0.4102	0.4076	0.4279	-
LSD 0.05		0.3888	0.8402	0.8349	0.8764	-
P-Value		0.0000	0.0000	0.0000	0.0000	-

Irrespective of fungicides, decreased number of infected plants were noted in plots sprayed with higher fungicide concentrations. Thus, for controlling onion downy mildew, onion crop may be sprayed with Cabriotop, Relly and Defer plus at 2 mg/L; while effective concentration for fungicide Score was 3ml/L. However, on the basis of overall performance related to number of infected plants, Cabriotop at 2mg/L concentration may be given preference for controlling onion downy mildew effectively.

Overall fungicidal effects on number of infected plants: Theoverall average number of infected plants under the influence of fungicidal treatment against onion downy mildew was significantly lower (1.78) in Cabriotop sprayed plantation; while number of infected plants increased in plots sprayed with Score (2.13), Relly (2.55) and Defer plus (2.27). However, number of infected plants increased significantly ($P<0.05$) in control plots (7.92); where no fungicides were sprayed (Fig-2). This showed that Cabriotop was more effective against onion downy mildew as reflected from the number of infected plants over rest of the fungicides; while Score, Relly and Defer plus were next to Cabriotop to control downy mildew.

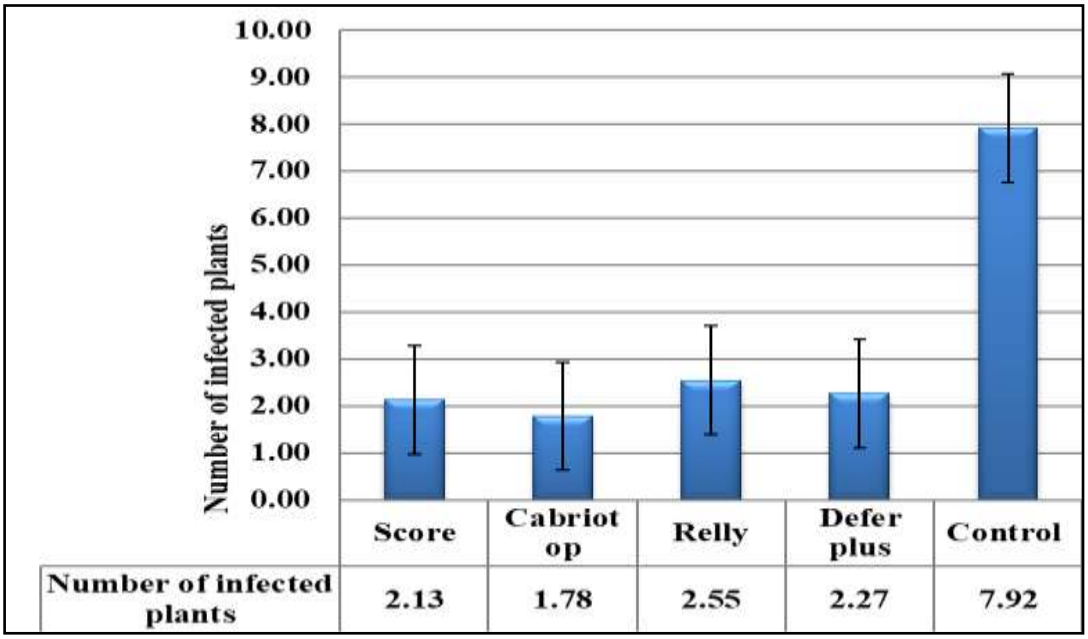

Fig.2: Average number of infected plants(out of 15 plants) by downy mildew (*Peronospora destructor*)in plots sprayed with different fungicides

Infection percentage Score: The higher concentrations of Score sprayed on onion plantation caused greater reduction in infection percentage of onion downy mildew (*Peronospora destructor*) as compared to lower concentrations and control. The infection percentage was lowest (11.08%) in Score sprayed plantation at 3ml/L concentration, followed by 2 ml/L concentration (13.84%); while maximum infection percentage (17.71%) was recorded in plots sprayed with Score @ 1 ml/L concentration. The average infection percentage at 1st, 2nd, 3rd and 4th observation in plots sprayed by Score was 6.47, 20.00, 16.30 and 14.07% against 15.56, 60.00, 66.67 and 68.89% in control, respectively (Table 3).

Cabriotop: The spray ofCabriotop at increased concentration more decreased downy mildew infection over lower concentrations and control. The infection percentage of onion leaves in crop sprayed with Cabriotop at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 15.00, 12.22 and 8.33 percent, respectively. At 1st, 2nd, 3rd and 4th observation, the average infection percentage were 1.00, 2.56, 1.89 and 1.67, against 15.56, 60.00, 66.67 and 68.89% in control, respectively. The application Cabriotop at 2mg/L concentration proved to be more effective to decrease infection percentage as compared to 1 mg/L and 0.5mg/L concentrations (Table 3).

Table 3: Infection percentage of downy mildew (*Peronospora destructor*) (On the basis of 15 plants) as affected by different fungicides and their concentrations

Treatments	Dose	Observations				Average
		First	Second	Third	Fourth	
T_1= Score	1ml/L	8.63	24.44	20.00	17.78	17.71 **A**
	2ml/L	6.47	20.00	15.56	13.33	13.84 **AB**
	3ml/L	4.32	15.56	13.33	11.11	11.08 **B**
Average		**6.47 B**	**20.00 B**	**16.30 BC**	**14.07 CD**	-
T_2 = Cabriotop	0.5mg/L	8.89	22.22	15.56	13.33	15.00 **A**
	1mg/L	6.67	17.78	13.33	11.11	12.22 **AB**
	2mg/L	4.44	11.11	8.89	8.89	8.33 **B**
Average		**6.67 B**	**17.04 B**	**12.59 C**	**11.11 D**	-
T_3 = Relly	0.5mg/L	8.56	26.67	22.22	24.44	20.47 **A**
	1mg/L	6.42	22.22	17.78	20.00	16.61 **B**
	2mg/L	4.28	17.78	15.56	17.78	13.85 **BC**
Average		**6.42 B**	**22.22 B**	**18.52 B**	**20.74 B**	-

T_4 = Defer plus	0.5mg/L	8.44	20.00	20.00	22.22	17.67 **A**
	1mg/L	6.33	20.00	17.78	17.78	15.47 **A**
	2mg/L	4.22	15.56	13.33	15.56	12.17 **B**
Average		**6.33 B**	**18.52 B**	**17.04 BC**	**18.52 BC**	-
T_5 = Control		15.56 A	60.00 A	66.67 A	68.89 A	-
S.E.±		1.2648	2.7355	2.7174	2.8523	-
LSD 0.05		2.5908	5.6034	5.5664	5.8426	-
P-Value		0.0000	0.0000	0.0000	0.0000	-

Relly: Theonion crop was also sprayed with fungicide Relly against downy mildew, and there was effective check on disease infection in Relly sprayed plotswhen compared with control. The average disease infection in plots sprayed by fungicide Relly at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 20.47, 16.61 and 13.85, respectively; while the average downy mildew infection in Relly sprayed plantation at 1st, 2nd, 3rd and 4th observation was 6.42, 22.22, 18.52 and 20.74percent against 15.56, 60.00, 66.67 and 68.89percent in control, respectively (Table 3).

Defer plus: SprayingDefer plus at different concentrations positivelyaffected the onion plantation by decreasing onion downy mildew infection as compared to control. The average downy mildew infection in onion plots sprayed with Defer plus at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 17.67, 15.47 and 12.17%, respectively. The average disease infection in Defer plus sprayed plots at 1st, 2nd, 3rd and 4th observation was 6.33, 18.52, 17.04 and 18.52 against 15.56, 60.00, 66.67 and 68.89 percent disease infection in control, respectively (Table 4). Regardless of fungicide products, higher concentration level cause more reduction in disease infection. Hence, for effective control of downy mildew, onion crop may be sprayed with Cabriotop, Relly and Defer plus at 2 mg/L; while effective concentration for fungicide Score was 3ml/L. Overall performance suggested the Cabriotop at 2mg/L concentration proved to be more effective to control downy mildew infection over rest of the fungicides.

Overall impact on infection percentage: Theoverall average infection percentage under the influence of fungicidal treatment against onion downy mildew was significantly lower (11.85%) in Cabriotop sprayed onion plantation; while infection percentage increased in plots sprayed with Score (14.21%), Relly (16.98%) and Defer plus (15.10%). However, infection percentage increased significantly ($P<0.05$) in control plots (52.78%); where no fungicides were sprayed (Fig-3). This proved that Cabriotop was most effective fungicide against onion downy mildew as compared to Score, Relly and Defer plus fungicide products.

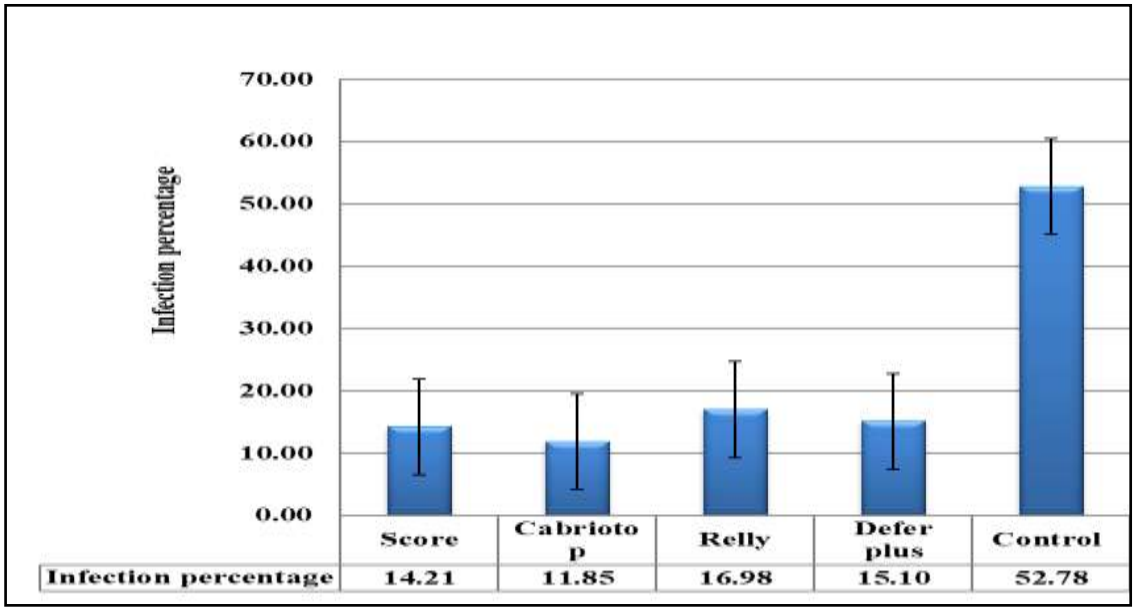

Fig. 3: Infection percentage of downy mildew (*Peronospora destructor*)in plots sprayed with different fungicides

Number of leaves per plant

Score: The onion crop sprayed with this fungicide at higher concentrations against onion downy mildew (*Peronospora destructor*) produced more leaves per plant as compared to lower concentrations and control. The number of leaves per plant was highest (6.59) when Score was applied at 3ml/L concentration, followed by 2 ml/L concentration (5.56); while least number of leaves per plant (5.10) was noted in plots sprayed with Score @ 1 ml/L concentration. The average leaves per plant at 1st, 2nd, 3rd and 4th observation in plots sprayed by Score was 5.62, 5.71, 5.79 and 5.88 against 4.63, 4.53, 4.40 and 4.80 in control, respectively (Table 4).

Cabriotop: The crop sprayed with Cabriotop fungicide against downy mildew infection at higher concentrationsresulted in more leaves per plant as compared to lower concentrations and control. The number of leaves of onion in crop sprayed with Cabriotop at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 6.53, 5.52 and 5.06 leaves, respectively. At 1st, 2nd, 3rd and 4th observation, the average number of leaves were 5.57, 5.66, 5.74 and 5.83, against 4.63, 4.53, 4.40 and 4.80 in control, respectively. The Cabriotop applied at 2mg/L concentration resulted in more leaves per plant as compared to 1 mg/L and 0.5mg/L concentrations (Table 4).

Relly: Thefungicide Relly sprayed against onion downy mildew showed higher effectiveness and the treated crop produced more leaves per plantthan the plotsof lower fungicide doses or control. The average leaves per plant in plots sprayed by fungicide Relly at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L were 6.53, 5.52 and 5.06, respectively; while at 1st, 2nd, 3rd and 4th observation the leaves per plant were 5.57, 5.66, 5.74 and 5.83leaves against 4.63, 4.53, 4.40 and 4.80leaves in control, respectively (Table 4).

Defer plus: Thisfungicide sprayed at different concentrations showed positive impact on onion leaves per plant as compared to lower concentrations and control. The average leaves per plant in plots sprayed with Defer plus at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L were 6.45, 5.44 and 4.99, respectively. The average number of leaves per plant in Defer plus sprayed plots at 1st, 2nd, 3rd and 4th observation was 5.50, 5.58, 5.67 and 5.75 against 4.63, 4.53, 4.40 and 4.80leaves per plant in control, respectively (Table 4). The crop sprayed with higher concentration of fungicides produced more leaves per plant due to significant decrease in disease infection. Hence, for effective control of downy mildew, onion crop may be treated with Cabriotop, Relly and Defer plus at 2 mg/L; while effective concentration for fungicide Score was 3ml/L. The overall crop performace in relation to leaves per plant suggested the Cabriotop at 2mg/L concentration was most effective to control downy mildew infection over other tested fungicides.

Overall treatment effect on leaves per plant: Theoverall treatment effect on leaves per plantshowed that Cabriotop sprayed against downy mildew on onion plantation proved more useful and the treated crop produced more leaves per plant (5.96); while number of leaves per plantdecreased in plots sprayed with Score (5.75), Relly (5.70) and Defer plus (5.62). However, number of leaves per plantdeclined ($P<0.05$) in control plots (4.59); where fungicide application was discontinued (Fig-4). The results clearly indicated that Cabriotop was most effective fungicide against onion downy mildew as compared to Score, Relly and Defer plus fungicide

Table 4: Number of leaves plant^{-1}as affected by different fungicides sprayed against downy mildew (*Peronospora destructor*)with different fungicides and their concentrations

Treatments	Dose	Observations				Average
		First	Second	Third	Fourth	
T_1= Score	1ml/L	4.98	5.06	5.14	5.21	5.10 **C**
	2ml/L	5.44	5.52	5.60	5.69	5.56 **B**
	3ml/L	6.44	6.54	6.64	6.74	6.59 **A**
Average		**5.62 AB**	**5.71 AB**	**5.79 B**	**5.88 B**	-
T_2 = Cabriotop	0.5mg/L	5.13	5.21	5.31	5.47	5.28 **C**
	1mg/L	5.60	5.68	5.80	5.97	5.76 **B**
	2mg/L	6.63	6.73	6.87	7.07	6.83 **A**
Average		**5.79 A**	**5.88 A**	**5.99 A**	**6.17 A**	-
T_3 = Relly	0.5mg/L	4.94	5.02	5.09	5.17	5.06 **C**
	1mg/L	5.39	5.47	5.56	5.64	5.52 **B**

	2mg/L	6.39	6.48	6.58	6.68	6.53 **A**
Average		**5.57 B**	**5.66 AB**	**5.74 B**	**5.83 B**	-
T_4 = Defer plus	0.5mg/L	4.88	4.95	5.02	5.10	4.99 **C**
	1mg/L	5.32	5.40	5.48	5.56	5.44 **B**
	2mg/L	6.30	6.40	6.49	6.59	6.45 **A**
Average		**5.50 B**	**5.58 B**	**5.67 B**	**5.75 B**	-
T_5 = Control		4.63 C	4.53 C	4.40 C	4.80 C	-
S.E.±		0.0914	0.1066	0.0989	0.0951	-
LSD 0.05		0.1871	0.2184	0.2026	0.1947	-
P-Value		0.0000	0.0000	0.0000	0.0000	-

Number of infected leaves per plant

Score: The infected leaves per plant of onion crop sprayed with fungicide Score at higher concentrations against onion downy mildew (*Peronospora destructor*) decreased considerably as compared to lower concentrations and control. The infected leaves per plant were least (1.46) when Score was applied at 3ml/L concentration, followed by 2 ml/L concentration (1.72); while highest infected leaves per plant (1.81) were noted in plots sprayed with Score @ 1 ml/L concentration. The average infected leaves per plant at 1st, 2nd, 3rd and 4th observation in plots sprayed by Score was 0.20, 2.04, 2.38 and 2.02 against 1.04, 4.36, 4.99 and 4.04 leaves in control, respectively (Table 5).

Cabriotop: The onion plantation treated with fungicide Cabriotop against downy mildew infection at higher concentrations resulted in least infected leaves as compared to lower concentrations and control. The number of infected leaves of onion in crop sprayed with Cabriotop at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 2.09, 2.03 and 1.38 leaves, respectively. At 1st, 2nd, 3rd and 4th observation, the average number of infected leaves was 0.41, 2.22, 2.62 and 2.07, against 1.04, 4.36, 4.99 and 4.04 in control, respectively. The Cabriotop applied at 2mg/L concentration proved to be highly effective by minimizing infected leaves per plant as compared to 1 mg/L and 0.5mg/L concentrations (Table 5).

Relly: Thecrop sprayed against onion downy mildew with fungicide Relly at higher concentrations showed effectiveness and the sprayed crop was noted with decreased infected leaves per plant as compared to lower fungicide doses or control. The average infected leaves per plant in plots sprayed by fungicide Relly at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L were 2.09, 2.03 and 1.38, respectively; while at 1st, 2nd, 3rd and 4th observation the infected leaves per plant were 0.41, 2.22, 2.62 and 2.07infected leaves against 1.04, 4.36, 4.99 and 4.04infected leaves in control, respectively (Table 5).

Defer plus: Application of Defer plus fungicide at higher doses against onion downy mildew caused lower number of infected leaves per plant as compared to decreased doses and control. The average infected leaves per plant in plots sprayed with Defer plus at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L were 1.86, 1.90 and 1.54, respectively. The average number of infected leaves per plant in Defer plus sprayed plots at 1st, 2nd, 3rd and 4th observation was 0.50, 2.10, 2.48 and 1.96 against 1.04, 4.36, 4.99 and 4.04 infected leaves per plant in control, respectively (Table 5). In onion plantation treated with higher concentration of fungicides,lower infected leaves per plant were recorded due to decreased disease infection. Hence, for effective control of downy mildew, onion crop may be treated with Cabriotop, Relly and Defer plus at 2 mg/L; while effective concentration for fungicide Score was 3ml/L. The overall crop condition such as infected leaves per plant suggested the Cabriotop at 2mg/L concentration was most effective to control downy mildew infection over other tested fungicides and infected leaves decreased considerably in test crop.

Overall treatment effect on infected leaves per plant: Theoverall effect of fungicide application treatment against downy mildew and consequent effect on infected leaves per plant showed that Cabriotop proved more useful and infected leaves per plant were least (1.26) in crop treated with this fungicide; while number of infected leaves per plant increased in plots sprayed with Score (1.66), Relly (1.83) and Defer plus (1.76). However, infected leaves per plant were highest ($P<0.05$) in control plots (3.61); where fungicide application was terminated (Fig-5). The study suggested that Cabriotop was more effective fungicide to control downy mildew as compared to Score, Relly and Defer plus fungicides as determined from the reduced number of infected leaves per plant.

Table 5: Number of infected leaves plant^{-1}of onion (On the basis of 15 plants) sprayed against downy mildew (*Peronospora destructor*)with different fungicides

Treatments	Dose	Observations				Average
		First	Second	Third	Fourth	
T_1= Score	1ml/L	0.40	2.20	2.60	2.05	1.81 **A**
	2ml/L	0.13	2.17	2.56	2.02	1.72 **A**
	3ml/L	0.06	1.77	2.00	2.00	1.46 **B**
Average		**0.20 B**	**2.04 B**	**2.38 B**	**2.02 B**	-
T_2 = Cabriotop	0.5mg/L	0.53	1.60	1.89	1.49	1.38 **A**
	1mg/L	0.40	1.53	1.81	1.43	1.29 **AB**
	2mg/L	0.13	1.37	1.61	1.27	1.10 **B**
Average		**0.36 B**	**1.50 C**	**1.77 C**	**1.40 C**	-
T_3 = Relly	0.5mg/L	0.50	2.52	2.97	2.35	2.09 **A**
	1mg/L	0.46	2.46	2.90	2.29	2.03 **A**
	2mg/L	0.26	1.68	1.99	1.57	1.38 **B**
Average		**0.41 B**	**2.22 B**	**2.62 B**	**2.07 B**	-
T_4 = Defer plus	0.5mg/L	0.89	2.10	2.48	1.96	1.86 **A**
	1mg/L	0.49	2.28	2.69	2.12	1.90 **A**
	2mg/L	0.13	1.93	2.28	1.80	1.54 **B**
Average		**0.50 B**	**2.10 B**	**2.48 B**	**1.96 B**	-
T_5 = Control		**1.04 A**	**4.36 A**	**4.99 A**	**4.04 A**	-
S.E.±		0.1095	0.1169	0.1313	0.0821	-
LSD 0.05		0.2292	0.2444	0.2738	0.1730	-
P-Value		0.0000	0.0000	0.0000	0.0000	-

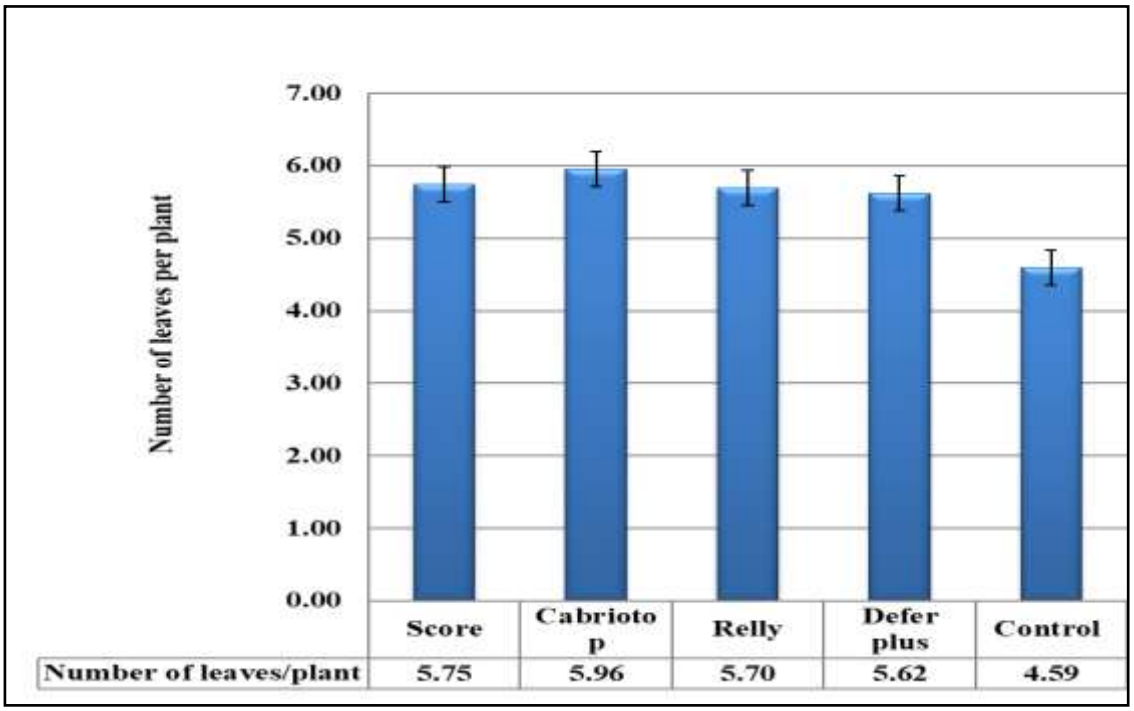

Fig. 4: Number of leaves per plant of onion sprayed with different fungicides against downy mildew (*Peronospora destructor*)

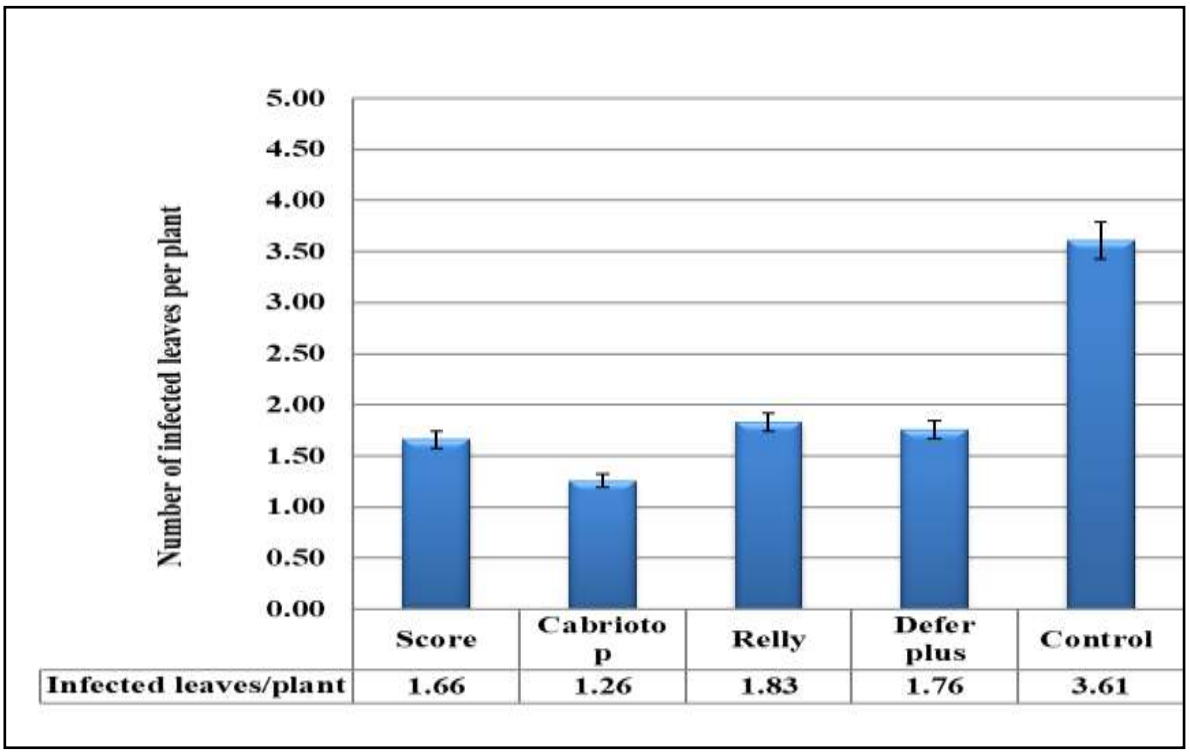

Fig. 5: Number of infected leaves per plant of onion sprayed with different fungicides against downy mildew (*Peronospora destructor*)

Average bulb weight(g) Score: The average bulb weight of onion as affected by application of this fungicide at higher concentrations against downy mildew (*Peronospora destructor*) was higher as compared to lower concentrations and control. The average bulb weightwas highest (126.39g) when Score was sprayed at 3ml/L concentration, followed by 2 ml/L concentration (120.07g); while lowest average bulb weight (114.07g) was noted in plots sprayed with Score @ 1 ml/L concentrationwith average bulb weight of 120.17g. The average bulb weightin untreated (control) was 74.34g (Table 6).

Cabriotop: The onion crop sprayed against downy mildew with Cabriotop at higher concentrations proved to be effective by increasing average bulb weight more than lower concentrations and control. The average bulb weight of onion in crop sprayed with Cabriotop at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 120.07g, 126.39g and 133.04g, respectively with average bulb weight of 126.50g against 74.34g in control (Table 6).

Relly: Thecrop sprayed to combat downy mildew with fungicide Relly at higher concentrations showed higher efficacy against the disease and increased bulb weight more than lower fungicide doses and control. The average bulb weight in plots sprayed with Relly at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 110.46g, 116.28 and 122.40g, respectively with average bulb weight of 116.38g against 74.34g in control (Table 6).

Defer plus: Thefungicide Defer plus applied at higher doses against downy mildew resulted in higher average bulb weight as compared to decreased fungicide doses and control. The average bulb weight in plots sprayed with Defer plus at 0.5 mg/L, 1.0 mg/L and 2.0 mg/L was 101.63g, 106.97g and 112.61g, respectively with overall average bulb weight of 107.07g against 74.34g bulb weight on average in control (Table 6). It was inferred that with application of fungicides, the powdery mildew infection was decreased appreciably particularly under the higher concentration of fungicides; and hence the average bulb weightwas increased as compared to control. However, to combat downy mildew, onion crop may be treated with Cabriotop, Relly and Defer plus at 2 mg/L; while effective concentration for fungicide Score was 3ml/L. The overall average bulb weight suggested that the Cabriotop at 2mg/L concentration was most effective to control downy mildew infection over other tested fungicides and produced heavier bulbs.

Overall treatment effect on average bulb weight: Theoverall effect of fungicide application against downy mildew and consequent effect on average bulb weightindicated that Cabriotop proved to be more useful and average bulb weightwas highest (126.5g) in crop treated with this fungicide; while average bulb weightdecreased in plots sprayed with Score (120.17), Relly (116.38g) and Defer plus (107.07g). However, average bulb weightwas least in control plots (74.34); where fungicide application was discontinued (Fig-6). The study concludes that Cabriotop fungicide was more efficacious to combat downy mildew as compared to Score, Relly and Defer plus as determined from the results on average bulb weight.

Table 6:Average bulb weight (g) of onion sprayed against downy mildew (*Peronospora destructor*)with different fungicides of different fungicides

Treatments	Dose	R1	R2	R3	Mean
T_1= Score	1ml/L	117.67	110.88	113.65	114.07 *de*
	2ml/L	123.87	116.71	119.63	120.07 *c*
	3ml/L	130.39	122.85	125.92	126.39 *b*
Average		**123.98**	**116.81**	**119.73**	**120.17 B**
T_2 = Cabriotop	0.5mg/L	123.87	116.71	119.63	120.07 *c*
	1mg/L	130.39	122.85	125.92	126.39 *b*
	2mg/L	137.25	129.32	132.55	133.04 *a*
Average		**130.50**	**122.96**	**126.03**	**126.50 A**
T_3 = Relly	0.5mg/L	113.96	107.37	110.06	110.46 *f*
	1mg/L	119.96	113.03	115.85	116.28 *d*
	2mg/L	126.27	118.97	121.95	122.40 *c*
Average		**120.06**	**113.12**	**115.95**	**116.38 C**
T_4 = Defer plus	0.5mg/L	104.84	98.78	101.25	101.63 *h*
	1mg/L	110.36	103.98	106.58	106.97 *g*
	2mg/L	116.17	109.46	112.19	112.61 *ef*
Average		**110.46**	**104.07**	**106.67**	**107.07 D**
T_5 = Control		**76.25**	**68.54**	**78.22**	**74.34 E**
				S.E.±	0.1821
				LSD 0.05	0.3730
				P-Value	0.0000

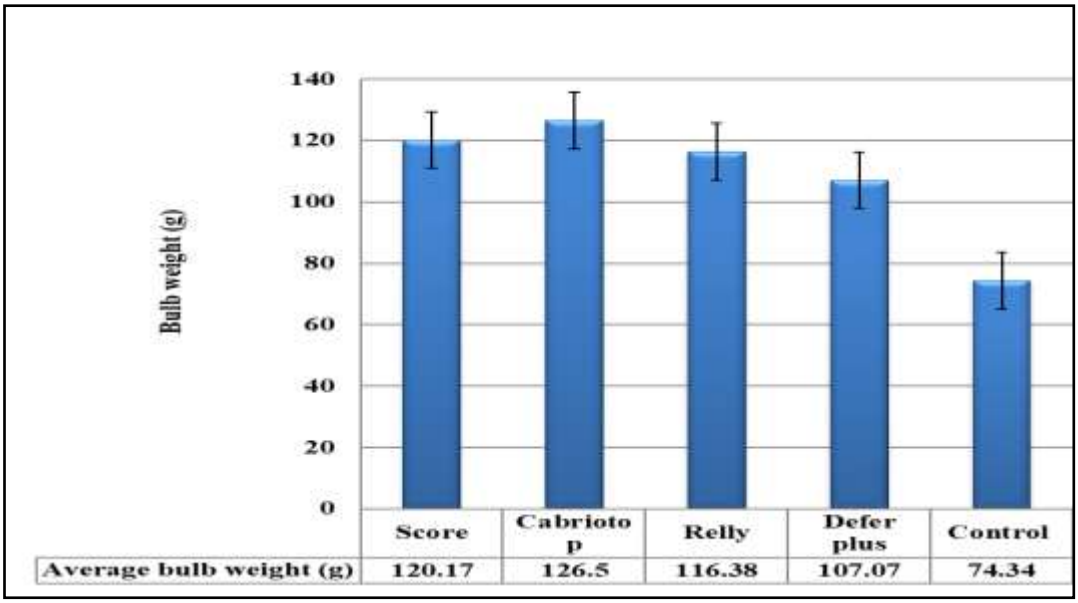

Fig. 6: Average bulb weight (g) sprayed with different fungicides against downy mildew (*Peronospora destructor*)

Discussion

Downy mildew, caused by *Peronospora destructor* is devastating fungal disease of onion and there are several methods to combat this disease. However, chemical control is yet the most effective method and fungicides are sprayed on occurrence of disease on onion crop. In this study, fungicides Score, Cabriotop; Relly and Defer plus were applied at different concentrations; while untreated (Control) was kept to compare the fungicide effectiveness. The major findings of the study are discussed in this chapter. The study showed significant difference ($P<0.05$) in efficacy of various fungicides against powdery mildew and subsequent growth and yield traits of onion.All the tested fungicides were effective to control onion downy mildew (*Peronospora destructor*) with their varied efficacies. All the tested fungicides were effective to control onion downy mildew (*Peronospora destructor*) with their varied efficacies. The Cabriotop proved as most efficacious fungicide and the sprayed onion crop at 1st, 2nd, 3rd and 4th observation resulted in infected plants 1.00, 2.56, 1.89 and 1.67 against 2.32, 9.00, 10.00 and 10.33 in control; disease infection 6.67, 17.04, 12.59 and 11.11 against 15.56, 60.00, 66.67 and 68.89% in control, infected leaves 0.41, 2.22, 2.62 and 2.07 against 1.04, 4.36, 4.99 and 4.04 in control, respectively with average bulb weight of 126.50g. The overall performance of crop treated with Cabriotop, Score, Relly, Defer plus and control ranked 1st, 2nd, 3rd, 4th and 5th with infected plants upto 1.78, 2.13, 2.55, 2.27 and 7.92; disease infection 11.85, 14.21, 16.98, 15.10 and 52.78%;infected leaves 1.26, 1.66, 1.83, 1.76 and 3.61/plant; average bulb weight of 126.5g, 120.17g, 116.38g, 107.07g and 74.34g, respectively. Muhammad *et al.* (2015) reported that fungicides decreased severity of powdery mildew disease markedly (from 72.66 to 91.66%) and improved onion bulb yield from 88 to 181.81 percent over control. Lepse *et al.* (2013) used different fungicides against *P. destructor* and the efficacy of these fungicides fluctuated between 6-91%. Whiteman and Beresford (2013) reported that fungicide efficacy is mainly linked with the application timing for downy mildew control and climatic conditions. Fazli *et al.* (2012) tested Aliette, Antracol, Benlate, Cobox, Daconil, Derosal, Dithane, Polyram, Ridomil and Topsin-M for evaluation of their efficacies against onion downy mildew caused by *Peronospora destructor*. The fungicide Ridomil remained most effective to reduce disease infection and increased onion yield. Raziq *et al.* (2008) tested Aliette, Antracol, Benlate, Cobox, Daconil, Derosal, Dithane, Polyram, Ridomil and Topsin-M fungicides against onion mildew disease and reported that all fungicides were effective to control the disease. However, Ridomil showed highest efficacy against the disease. Tahir *et al.* (1990) reported that minimum disease severity was recorded in Ridomil treated plots (13.13 %) follwed by Topsin-M (20.00 %) and Aliette (22.50 %), while maximum disease severity (68.75 %) was observed in the untreated plot. Khokhar and Jaffrey (2000) examined efficacy of Ridomil MZ 72 WP, Antracol 70 WPM, Liromanzeb 80 Dithane M 45 WP, Polyram Combi and Cupravit fungicides against downy mildew disease of onion; and found that Ridomil MZ 72 WP was highly effective against the target disease followed by Antracol 70 WP, Liromanzeb 80 Wp and others. Elena *et al.* (2008) reported that 03 sprays of fungicides suppressed downy mildew incidence significantly and efficacy averaged 74.38–89.36% and increased the marketable onion yield by 4.3–26.3%.In the present study, several fungicides were evaluated under field conditions to find effective and economical fungicides for the control of this important disease. The study further showed that fungicide Cabriotop sprayed onion plantation resulted in maximum leaves length, least infected plants, least infection percentage, maximum leaves per plant, least infected leaves per plant and maximum average bulb weight; while fungicides Score, Relly and Defer plus ranked 2nd, 3rd and 4th in overall crop performance and disease control.The highest concentrations of Cabriotop (2mg/L), Score (3ml/L), Relly (2mg/L) and Defer plus (2 mg/L) proved to be more effective to control downy mildew by maximum reduction in disease infection and improving crop vegetation and average bulb weight as compared lower concentrations.Chung *et al.* (2016) evaluated several fungicides to control onion downy mildew and reported 91.4% disease control when applied fungicides at higher concentrations. Develashand (2016) argued that downy mildew of onion caused by *Peronospora destructor*, can be controlled by several management strategies, such chemical, botanical extracts, evaluated the effect of heat treatment of bulbs and fungicide sprays on the management of downy mildew *Peronospora destructor* of onion. Narla *et al.* (2016) used several fungicides against downy mildew in onion and reported that Tata Master™ Metalaxyl8%+Mancozeb 64% remained to most

efficacious products to combat downy mildew disease severity. Sabry (2017) reported that Amistar Top fungicide showed best results reducing downy mildew infections upto 96.32 and 97.58% on yellow and red onion, respectively. Raziq*et al.* (2018) tested several fungicides against destructive disease of onion (downy mildew) caused by *Peronospora destructor* Berk and Ridomil was most effective to reduce disease severity and enhance onionyield.

Conclusions

All the tested fungicides were effective to control onion downy mildew (*Peronospora destructor*) with their varied efficacies. The Cabriotop sprayed onion plantation resulted in maximum leaves length, least infected plants, least infection percentage, maximum leaves per plant, least infected leaves per plant and maximum average bulb weight; while fungicides Score, Relly and Defer plus ranked 2nd, 3rd and 4th in overall crop performance and disease control. The highest concentrations of Cabriotop (2mg/L), Score (3ml/L), Relly (2mg/L) and Defer plus (2 mg/L) proved to be more effective to control downy mildew by maximum reduction in disease infection and improving crop vegetation and average bulb weight as compared lower concentratio

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