

Original Research Article

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Field Evaluation of Fungicides for the Management of Powdery Mildew (*Erysiphe cruciferarum* Opiz ex. Junell) Disease of Mustard (*Brassica juncea* (L.) Czern. & Coss.)

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ABSTRACT

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In field evaluation of different fungicides against powdery mildew (*Erysiphe cruciferarum* Opiz ex. Junell) disease of mustard (*Brassica juncea* (L.) Czern. & Coss.) four sprays of hexaconazole at 0.005 per cent concentration starting from initial appearance of symptoms to twelve days interval recorded the least per cent disease intensity (28.17%) and maximum disease control (54.17%) which coincides with the highest seed yield of 2225 kg/ha as compared to no spray control with 30.04 per cent increase in yield. The next best effective fungicides were penconazole followed by difenoconazole, dinocap, wettable sulphur and azoxystrobin. The highest incremental cost: benefit ratio (ICBR) was obtained in four sprays of hexaconazole (1:4.63) followed by wettable sulphur 0.2 per cent (1:3.36) and penconazole 0.010 per cent (1:1.07). The maximum oil (34.37%), protein (18.05%) and 1000 seed weight (5.39 g) was also recorded in the treatment of hexaconazole (0.005%). The corresponding increase in oil, protein and 1000 seed weight were 11.95, 26.05 and 22.78 per cent, respectively.

Introduction

Mustard [*Brassica juncea* (L.) Czern. & Coss.] is the most important oilseed crop grown under a wide range of agroclimatic conditions in India. Powdery mildew caused by *Erysiphe cruciferarum* is an important fungal foliar disease in most mustard growing area of North Saurashtra region of Gujarat state. The disease occurs on all above ground parts of the plants and cause considerable yield loss in terms of quality and quantity.

Saharan and Sheoran (1985) reported 17.5 per cent reduction in grain yield of mustard due to powdery mildew disease. In recent years, the yield loss due to this disease in mustard was 16.97 per cent under north Gujarat conditions (Dange *et al.*, 2002).

The disease management through some fungicides was reported to be effective, but information is lacking on efficacy of fungicides as well as on economics aspects under North Saurashtra conditions. Hence, this

research work was undertaken to study the most economic fungicide for effective management of the disease.

Materials and Methods

A field experiment was conducted during three consecutive *rabi* seasons of 2007-08 to 2009-10 at Dry Farming Research Station, Junagadh Agricultural University, Jam-Khambhalia, Gujarat, India to find out the effective fungicide against powdery mildew. The experiment was laid out in randomized block design with four repetitions using mustard variety GM-2. The crop was sown on 16th October during all the three consecutive years with a row to row and plant to plant spacing of 45 cm x 15 cm in a plot of 6.0 m x 2.7 m size adopting recommended agronomic practices. The efficacy of four systemic fungicides, namely, hexaconazole 5% EC, difenoconazole 25% EC, penconazole 10% EC, azoxystrobin 25% SC, two non-systemic fungicides *viz.*, dinocap 48% EC and wettable sulphur 80% WP were tested with water spray control and untreated check (no spray control). The fungicide solutions were prepared by dissolving known quantity of fungicide in water to get desired concentration. The first date on which powdery mildew symptoms were observed in each treatment was considered as disease onset. The spraying of fungicides was carried out at onset of disease followed by three additional ones at 12 days intervals.

Treatment wise seed yield of net plot area was recorded after harvest of the crop. Seed yield in kg/ha was worked out by multiplying yield of net plot area with multiple factor. Weight of 1000-seeds was also recorded and ICBR was calculated by dividing the increased income over control with total expenditure. Data were analyzed statistically and results have been discussed at 5 per cent level of critical difference.

Disease assessment

Observations on disease intensity were recorded from randomly selected ten tagged plants from each treatment after seven days of last spray (Table 1) using 0-12 scale (Solanki, 1995).

The PDI was calculated using the formula given by Wheeler (1969).

$$PDI = \frac{\sum \text{Total rating}}{\text{Total plants observed} \times \text{Maximum disease rating}} \times 100$$

The percentage disease control and the percentage deviation in yield were calculated with the help of the following formula (Mathur *et al.*, 1971).

$$\text{Disease control (\%)} = \frac{\text{P.D.I. in check} - \text{P.D.I. in treatment}}{\text{P.D.I. in check}} \times 100$$

$$\text{Yield increase (\%)} = \frac{\text{Yield in treatment} - \text{Yield in check}}{\text{Yield in check}} \times 100$$

Estimation of oil and protein content

Oil and protein content in the seeds were determined directly by using Near Infrared Spectroscopy as described by Mandal *et al.*, (2005). The mustard seed samples randomly drawn from each treatment were ground in mortar with pestle and screened through fine sieve. Thereafter, about five g of each ground seed samples were uniformly placed in a small ring cup (3.8 cm) for scanning on a Monocromator NIR reflectance spectroscopy for the measurement of oil and protein content at Food Testing Laboratory, Department of Biotechnology, Junagadh Agricultural University, Junagadh.

1000 seeds weight (g)

Counting and weighing of 1000 seeds randomly drawn from seed samples of each

treatment was done by electronic digital balance. The three year data on effect of different treatments of fungicides on PDI, seed yield, oil content, protein content and 1000 seeds weight were pooled and analyzed as per the standard statistical method.

Results and Discussion

North Saurashtra Agro-climatic Zone of Gujarat occupies uneven and erratic pattern of rainfall. After harvesting of *kharif* groundnut, bajra or sesame crop, sowing of mustard in *rabi* season is one of the less expensive and economical practice adopted by the farmers with limited irrigation facilities. In mustard, incidence of powdery mildew disease was one of the most serious problems for low yield which appears after flowering and needs proper management strategies for better yield. Different fungicides have been recommended to manage the disease, but its efficacy under field condition still remains unknown for this region. Hence, present investigation was undertaken during three consecutive *rabi* season to evaluate the efficacy of different fungicides against powdery mildew disease of mustard.

Evaluation of fungicides *in vivo*

For testing the efficacy of different fungicides against *E. cruciferarum* on mustard, six different fungicides viz., hexaconazole, difenoconazole, penconazole, azoxystrobin, dinocap and wettable sulphur were tested on mustard variety Gujarat Mustard-2 under field conditions during three consecutive *rabi* season of 2007-08 to 2009-10.

The first spray of the fungicide was started after onset of the disease and remaining sprays of fungicides were carried out at twelve days interval. Observations on powdery mildew intensity was recorded at seven days after last spray by selecting ten plants randomly from

each plot using 0-12 scale as described earlier. Treatment wise data on per cent disease intensity (PDI) and per cent disease control are given in Table 2 and Figure 1. The mustard yield and economics, oil and protein content of mustard seeds and 1000 seeds weight were also identified under different fungicidal treatments are given in Table 3, 4, 5 and 6, respectively.

Effect of fungicides on percent disease intensity

All the tested fungicides reduced the disease incidence and increased seed yield as compared to no spray control. During the year 2007-08, 2008-09 and 2009-10 hexaconazole at 0.005 per cent concentration found most effective in managing powdery mildew disease with minimum per cent disease intensity (PDI) of 27.81, 29.09 and 27.65 and found statistically at par with penconazole at 0.010 and difenoconazole at 0.025 per cent concentration with (32.42, 33.47 and 30.98) and (33.65, 33.67 and 32.78) PDI, respectively. They were also remained at par with dinocap at 0.048 per cent (34.16 and 34.30 PDI) during 2007-08 and 2008-09, respectively. The next effective fungicide during the year 2009-10 was dinocap 0.048 per cent (34.06 PDI) but was at par with wettable sulphur 0.2 per cent and azoxystrobin 0.025 per cent with 35.11 and 36.15 PDI, respectively. The water spray control recorded (84.00, 85.43 and 82.92) PDI as against (88.80, 90.27 and 85.43) PDI in no spray control treatment, respectively during the year 2007-08 to 2009-10.

The three years pooled analysis indicated significant difference in PDI as compared to no spray control. It is evident from the Table 2 that hexaconazole at 0.005 per cent concentration could significantly reduce the disease as compared to remaining fungicides. It showed 28.17 PDI and reduced disease to

the extent of 54.17 per cent over control. The next best fungicide was penconazole which recorded 32.30 PDI and reduced the disease to an extent of 50.49 per cent over no spray control and found equally effective as difenoconazole, dinocap and wettable sulphur with the corresponding PDI of 33.38, 34.35 and 35.11 and reduced the disease to an extent of 49.55, 48.71 and 48.05 per cent over no spray control, respectively. The fungicide azoxystrobin was less effective in managing the disease having 35.81 PDI and 47.45 per cent reduction over no spray control. The water spray control (84.14 PDI) also reduced the disease severity to an extent of 4.89 per cent over no spray control (88.25 PDI) which corroborates the findings of Yarwood (1939) and Singh and Solanki (1974) that water spray also checks the development of powdery mildew.

The results in respect of efficacy of hexaconazole fungicide in present findings are in agreement with Shabbir and Yadav (2009). Patel and Patel (2008) also reported hexaconazole as the next best fungicide after tridemorph while working on powdery mildew of mustard. The superiority of other fungicides namely, penconazole, dinocap and wettable sulphur was also noted by Shete *et al.*, (2008) for management of powdery mildew of mustard under Maharashtra condition. Singh (1986); Patel *et al.*, (1992) and Singh and Singh (2003) also found dinocap and wettable sulphur as effective non systemic fungicide for the management of powdery mildew of mustard. The efficacy of triazole fungicides against powdery mildew of various crops were also reported by Dhruj *et al.*, (2000) and Shivanna *et al.*, (2006) and Chovatiya (2010).

Effect of fungicides on seed yield (kg/ha)

An increase in the seed yield was observed in all the fungicidal treatments as compared to no spray control treatment. The results presented

in Table 3 and depicted in Figure 1 indicated that all fungicidal treatments significantly increased the mustard yield ranging from 20.51 to 30.04 per cent as compared to no spray control. During the year 2007-08, 2008-09 and 2009-10 significantly the maximum seed yield of 2250, 2160 and 2266 kg/ha were recorded in the treatment of hexaconazole at 0.005 per cent concentration, but it was found statistically at par with penconazole (2161, 2105 and 2213 kg/ha), difenoconazole (2114, 2076 and 2199 kg/ha), dinocap (2104, 2053 and 2193 kg/ha), wettable sulphur (2091, 2046 and 2133 kg/ha) and azoxystrobin (2082, 2001 and 2104 kg/ha) during all the three consecutive *rabi* seasons. The minimum seed yield was found in water spray control 1791, 1709 and 1804 kg/ha without significant difference to no spray control with 1747, 1635 and 1752 kg/ha, respectively during the year 2007-08 to 2009-10.

Three years pooled analysis indicated significant differences due to fungicidal sprays as compared to no spray control treatments.

Maximum seed yield was found in hexaconazole at 0.005 per cent concentration (2225 kg/ha) which remained statistically at par with penconazole (2160 kg/ha), difenoconazole (2130 kg/ha), dinocap (2117 kg/ha), wettable sulphur (2090 kg/ha) and azoxystrobin (2062 kg/ha). However, there was no significant yield difference between water spray control (1768 kg/ha) and no spray control (1711 kg/ha) treatments.

Per cent increase in seed yield over no spray control was also recorded higher in the treatment of hexaconazole (30.04%) followed by penconazole (26.24%), difenoconazole (24.49%), dinocap (23.73%), wettable sulphur (22.15%) and azoxystrobin (20.51%), respectively. The water spray control treatment also recorded 3.33 per cent increase in seed yield over no spray control.

The results are in close conformity with the findings of Patel and Patel (2008) and Shabbir and Yadav (2009) who have reported similar effect of different fungicides against powdery mildew of mustard. The results in respect of efficacy of dinocap and wettable sulphur are in agreement with Singh and Solanki (1974); Patel *et al.*, (1992); Singh and Singh (2003) and Shete *et al.*, (2008) while working with management of powdery mildew of mustard. The triazole fungicides significantly reduced the powdery mildew disease and increased the yield of different crops were also reported by Chovatiya (2010) and Dinesh *et al.*, (2011). Earlier findings of Dhruj *et al.*, (2000) and Shivanna *et al.*, (2006) on promising efficacy of different triazole fungicides against powdery mildew substantiate the present findings regarding triazole fungicides.

Incremental cost: benefit ratio

Based on ICBR (Table 3) four spraying of hexaconazole 0.005 per cent (1: 4.63) first at the time of initial appearance of the symptoms and remaining three sprays at an interval of 12

days are recommended for the management of powdery mildew of mustard under North Saurashtra conditions followed by wettable sulphur (1:3.36) and penconazole (1: 1.07).

Oil content (%)

It is evident from the pooled mean data presented in Table 4 and Figure 2 that all fungicidal treatments significantly increased the oil content ranging from 6.32 to 11.95 per cent as compared to no spray control.

Among different fungicides tested, hexaconazole recorded significantly the maximum oil content of 34.37 per cent and found at par with penconazole (34.03%) and difenoconazole (33.57%).

In the individual year, these three fungicides significantly increased oil content except in the year 2008-09 for difenoconazole in comparison to both the checks. The next better fungicides were dinocap (33.12%), wettable sulphur (32.99%) and azoxystrobin (32.64%) as compared to no spray control (30.70%).

Table.1 Rating scale with infection/phenotypic class

Rating Scale	Infection/phenotypic class
0	Healthy (i.e. no disease symptoms on the plant)
I	Few whitish specks (1 to 5) on leaf
II	Up to 25 per cent leaf area covered with whitish specks
III	> 25 to 50 per cent leaf area covered with whitish fungal growth
IV	More than 50 per cent area of leaf covered with whitish fungal growth and few whitish specks on stem
V	More than 50 per cent area of leaf and up to 25 per cent area on stem covered with whitish growth
VI	More than 50 per cent area of leaf and stem covered with whitish growth
VII	More than 50 per cent area of leaf and stem covered by whitish growth with few whitish specks on branch(es)
VIII	More than 50 per cent area of leaf, stem and up to 25 per cent area of branch(es) covered with whitish growth
IX	More than 50 per cent area of leaf, stem and branch(es) covered with whitish fungal growth
X	More than 50 per cent area of leaf, stem and branch(es) covered with whitish fungal growth with few whitish specks on siliquae
XI	More than 50 per cent area of leaf, stem, branch(es) covered with whitish fungal growth and up to 25 per cent area of siliquae covered with whitish growth
XII	More than 50 per cent area of leaf, stem, branch(es) and siliquae covered with whitish growth (i.e. entire plant covered with whitish fungal growth)

Table.2 Per cent disease intensity as influenced by different fungicides

Treatments	Conc. (%)	Disease intensity (%)			Pooled Mean	Disease control (%)
		2007-08	2008-09	2009-10		
Hexaconazole 5% EC	0.005	31.83 (27.81)*	32.64 (29.09)	31.72 (27.65)	32.06 (28.17)	54.17
Difenoconazole 25% EC	0.025	35.46 (33.65)	35.47 (33.67)	34.93 (32.78)	35.29 (33.38)	49.55
Penconazole 10% EC	0.010	34.71 (32.42)	35.35 (33.47)	33.82 (30.98)	34.63 (32.30)	50.49
Azoxystrobin 25% SC	0.025	36.59 (35.52)	36.71 (35.73)	36.96 (36.15)	36.76 (35.81)	47.45
Dinocap 48% EC	0.048	35.77 (34.16)	35.85 (34.30)	36.03 (34.06)	35.88 (34.35)	48.71
Wett. sulphur 80% WP	0.2	36.11 (34.74)	36.58 (35.52)	36.34 (35.11)	36.34 (35.11)	48.05
Control (Water spray)	-	66.42 (84.00)	67.56 (85.43)	65.59 (82.92)	66.53 (84.14)	4.89
Control (No spray)	-	70.45 (88.80)	71.82 (90.27)	67.56 (85.43)	69.95 (88.25)	-
S.Em.+		1.36	1.35	1.38	0.74	
C.D. at 5%		4.00	3.96	4.06	2.08	
C.V.%		6.27	6.12	6.45	6.28	

* Data given in parenthesis are retransformed values.

Table.3 Effect of fungicidal sprays on yield and economics of mustard in field condition

Treatments	Conc. (%)	Seed yield (kg/ha)			Pooled Mean	Yield increase (%)*	ICBR
		2007 -08	2008 -09	2009 -10			
Hexaconazole 5% EC	0.005	2250	2160	2266	2225	30.04	1:4.63
Difenoconazole 25% EC	0.025	2114	2076	2199	2130	24.49	1:0.59
Penconazole 10% EC	0.010	2161	2105	2213	2160	26.24	1:1.07
Azoxystrobin 25% SC	0.025	2082	2001	2104	2062	20.51	1:-0.44
Dinocap 48% EC	0.048	2104	2053	2193	2117	23.73	1:0.83
Wett. sulphur 80% WP	0.2	2091	2046	2133	2090	22.15	1:3.36
Control (Water spray)	-	1791	1709	1804	1768	3.33	-
Control (No spray)	-	1747	1635	1752	1711	-	-
S.Em.+		111.26	118.38	117.00	60.53		
C.D. at 5%		327	348	344	171		
C.V.%		10.89	12.00	11.23	11.37		

* Yield increase (%) over control (No spray)

Table.4 Oil content of mustard as influenced by different fungicidal sprays for the management of powdery mildew disease of mustard

Treatments	Oil content (%)			Pooled mean	Oil content increase (%)
	2007-08	2008-09	2009-10		
Hexaconazole 5% EC	33.48	34.03	35.61	34.37	11.95
Difenoconazole 25% EC	32.75	33.40	34.56	33.57	9.35
Penconazole 10% EC	33.04	33.97	35.08	34.03	10.85
Azoxystrobin 25% SC	32.21	32.59	33.12	32.64	6.32
Dinocap 48% EC	32.63	33.05	33.68	33.12	7.88
Wett. sulphur 80% WP	32.53	33.02	33.43	32.99	7.46
Control (Water spray)	30.55	31.29	31.81	31.21	1.66
Control (No spray)	30.40	30.14	31.56	30.70	-
S.Em.+	0.71	0.82	0.78	0.41	
C.D. at 5%	2.09	2.40	2.28	1.15	
C.V.%	4.40	5.00	4.62	4.68	

Table.5 Protein content of mustard as influenced by different fungicidal sprays for the management of powdery mildew disease of mustard

Treatments	Protein content (%)			Pooled mean	Protein content increase (%)
	2007-08	2008-09	2009-10		
Hexaconazole 5% EC	18.07	17.49	18.60	18.05	26.05
Difenoconazole 25% EC	17.39	16.67	17.81	17.29	20.74
Penconazole 10% EC	17.47	17.06	18.03	17.52	22.35
Azoxystrobin 25% SC	16.96	16.41	16.91	16.76	17.04
Dinocap 48% EC	17.33	16.60	17.29	17.07	19.20
Wett. sulphur 80% WP	17.06	16.46	17.00	16.84	17.60
Control (Water spray)	15.52	14.97	15.38	15.29	6.77
Control (No spray)	14.49	14.02	14.45	14.32	-
S.Em.+	0.42	0.35	0.47	0.24	
C.D. at 5%	1.23	1.02	1.39	0.68	
C.V.%	5.00	4.30	5.59	5.01	

Table.6 Effect of fungicides applied for management of powdery mildew disease of mustard on 1000 seeds weight (g)

Treatments	1000 seed weight (g)			Pooled mean	Increase in 1000 seeds weight (%)*
	2007-08	2008-09	2009-10		
Hexaconazole 5% EC	5.53	5.30	5.35	5.39	22.78
Difenoconazole 25% EC	5.31	5.21	5.20	5.24	19.36
Penconazole 10% EC	5.42	5.26	5.28	5.32	21.18
Azoxystrobin 25% SC	5.17	5.17	5.13	5.16	17.54
Dinocap 48% EC	5.40	5.18	5.18	5.25	19.59
Wett. sulphur 80% WP	5.29	5.17	5.14	5.20	18.45
Control (Water spray)	4.69	4.19	4.63	4.50	2.51
Control (No spray)	4.61	4.10	4.45	4.39	-
S.Em.+	0.07	0.06	0.07	0.06	
C.D. at 5%	0.21	0.19	0.20	0.19	
C.V.%	2.73	2.58	2.63	2.65	

* Increase in test weight (%) over control (No spray)

Fig.1 Per cent disease control, increase in seed yield (%), mean PDI and seed yield as influenced by different fungicides *in vivo*

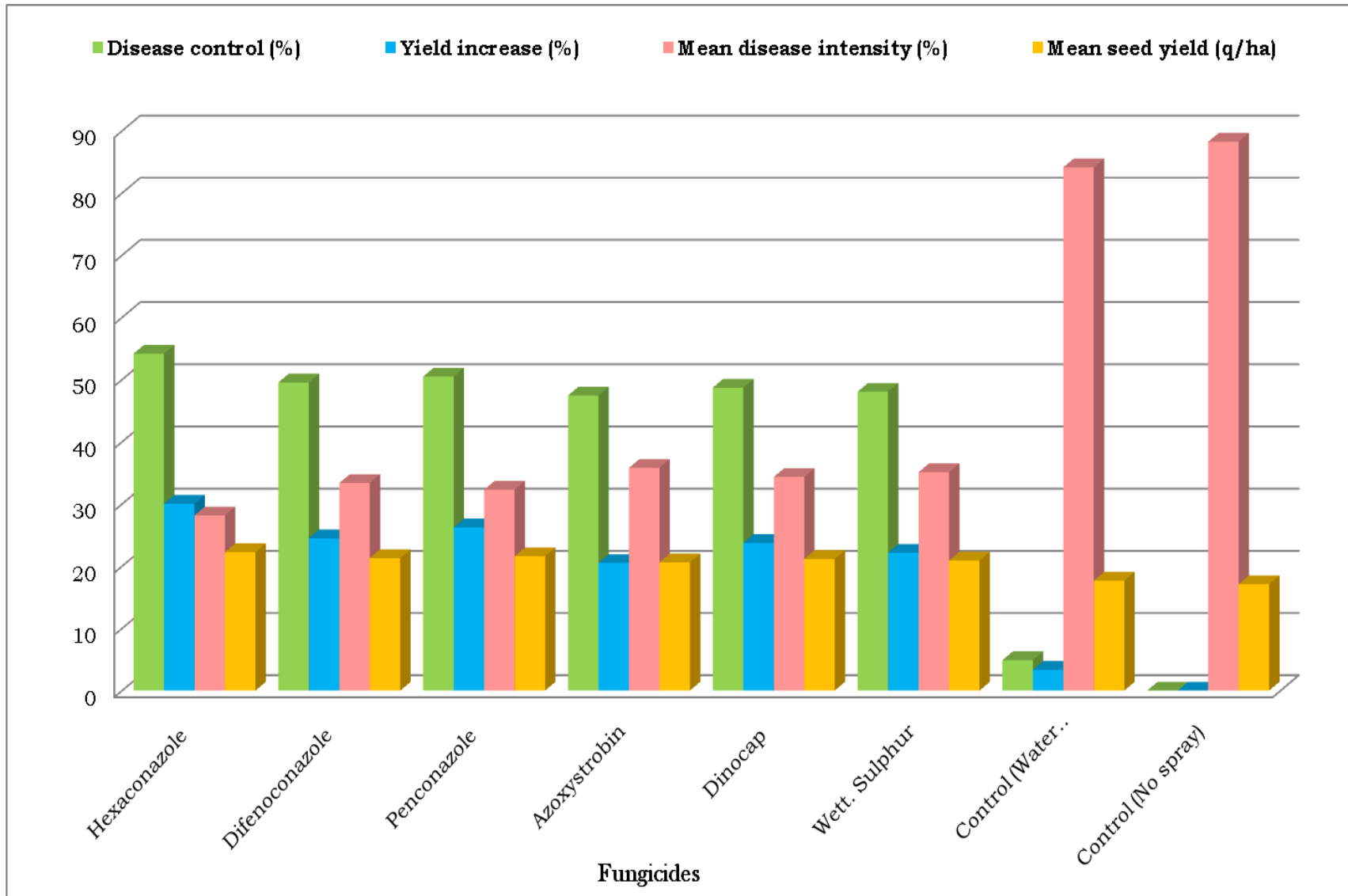
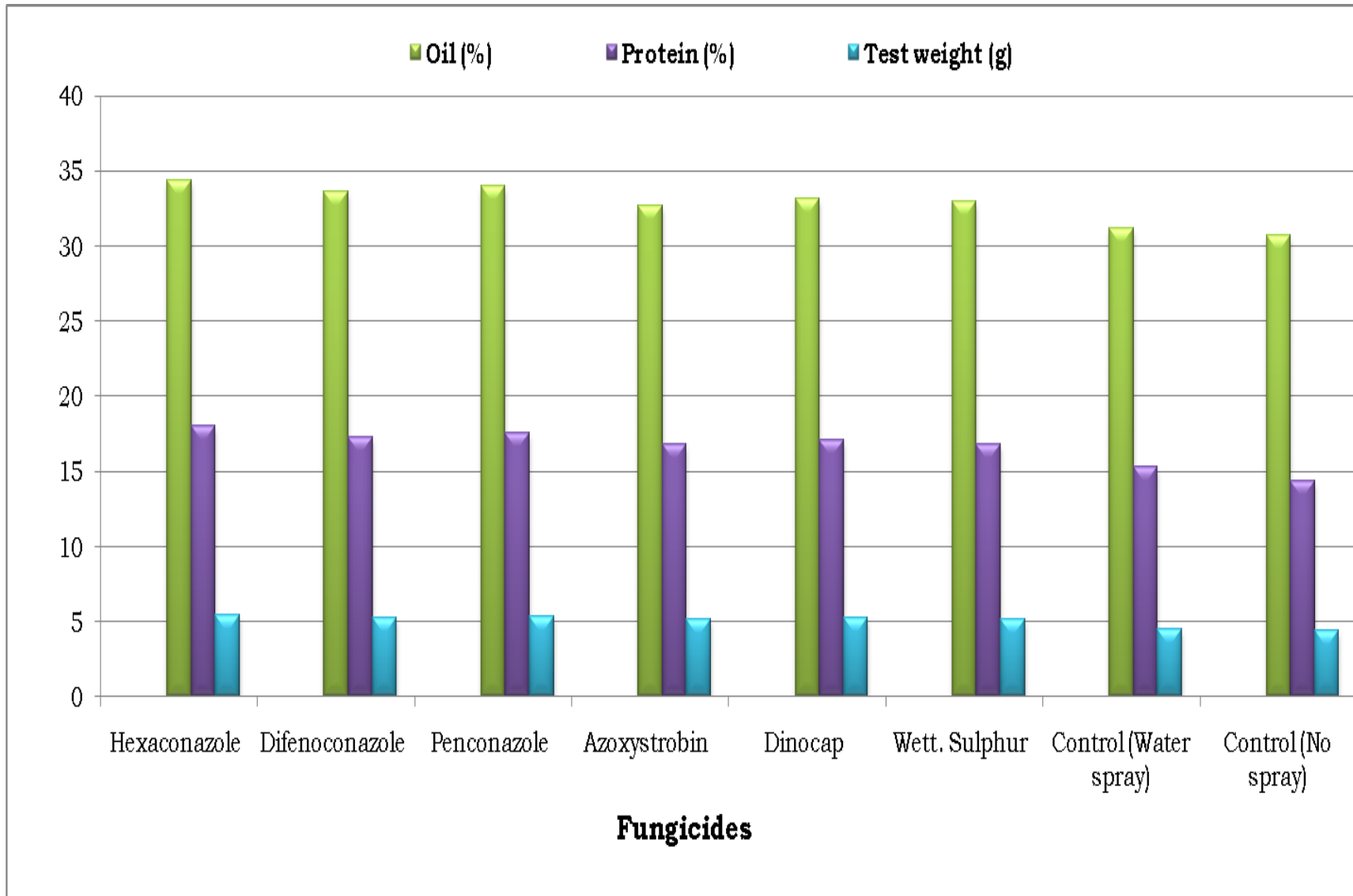


Fig.2 Oil, protein content (%) and 1000 seeds weight (g) as influenced by different fungicides under field condition



Similarly, the maximum per cent increase in oil content was recorded in the treatment of hexaconazole (11.95%) followed by penconazole (10.85%), difenoconazole (9.35%), dinocap (7.88%), wettable sulphur (7.46%) and azoxystrobin (6.32%) over no spray control.

The present investigation was in close conformity with the similar type of findings as reported from Canada for leaf blight of mustard caused by *Alternaria brassicae* by Degenhardt *et al.*, (1974). They noticed losses in oil content up to 4.8 per cent, but higher losses (14.58-35.97%) were recorded in India for same disease (Ansari *et al.*, 1988). Shrestha (2005) reported negative effect on oil content causing losses in mustard oil between 4.2 and 4.5 per cent under Nepal conditions due to *Alternaria* leaf blight disease.

Protein content (%)

It is evident from the data presented in Table 5 and Figure 2 that all fungicidal treatments significantly increased the protein content ranging from 17.04 to 26.05 per cent as compared to no spray control. Among different treatments tried, hexaconazole found significantly superior over rest of the treatments and recorded maximum protein content of 18.05 per cent and found at par with penconazole (17.52%). The next best treatment was difenoconazole (17.29%), dinocap (17.07%) and wettable sulphur (16.84%). Azoxystrobin recorded minimum 16.76 per cent protein content as compared to no spray control (14.32%) under pooled analysis.

In the individual year, all fungicidal treatments significantly increased protein content as compared to both the checks. During the year 2007-08, hexaconazole found effective and recorded 18.07 per cent protein

content followed by penconazole (17.47%), difenoconazole (17.39%), dinocap (17.33%) and wettable sulphur (17.06%). Similar trend was also noticed during the year 2008-09 and 2009-10. The azoxystrobin was the least effective among all fungicides tested during the three years.

Similarly, the maximum 26.05 per cent increase in protein content was recorded in the treatment of hexaconazole followed by penconazole (22.35%), difenoconazole (20.74%), dinocap (19.20%), wettable sulphur (17.60%) and azoxystrobin (17.04%) over no spray control.

More or less similar type of findings was also reported by Mert-Turk *et al.*, (2008). They investigated the effect of fungicidal treatment coupled with nitrogen fertilization on powdery mildew caused by *E. cruciferarum* of oilseed rape on protein, oil, oleic acid, linolenic acid etc. using near infrared spectroscopy. They concluded that fungicidal treatments significantly increased oil contents in all varieties tested.

1000 seeds weight (g)

Effect of fungicides on 1000 seeds weight of mustard (Table 6 and Fig. 2) over three years pooled results revealed equally good effect of hexaconazole (5.39 g) followed by penconazole (5.32 g), dinocap (5.25 g) and difenoconazole (5.24 g) as compared to no spray control. The least test weight was recorded in the treatment of azoxystrobin (5.16 g). However, there was no significant difference in test weight between water spray control (4.50 g) and no spray control (4.39 g) treatments. Individual years also showed more or less similar trends. The maximum per cent increase in 1000 seeds weight was recorded in hexaconazole (22.78%) followed by penconazole (21.18%), dinocap (19.59%), difenoconazole (19.36%), wettable sulphur

(18.45%) and azoxystrobin (17.54%) over no spray control. Similar type of findings were also reported by Patel (2006) who concluded that foliar sprays of fungicides for the control of powdery mildew of mustard gave test weight in the range of 5.66-5.82 g as compared to 5.39 g in control.

Effect of different fungicides against *E. cruciferarum* on mustard was tried in field condition during three consecutive *rabi* seasons of 2007-08 to 2009-10. The minimum per cent disease intensity 28.17 was recorded in the treatment of hexaconazole with 54.17 per cent disease control yielding 2225 kg/ha mustard seed (pooled) followed by penconazole (2160 kg/ha), difenoconazole (2130 kg/ha), dinocap (2117 kg/ha), wettable sulphur (2090 kg/ha) and azoxystrobin (2062 kg/ha). Similarly, per cent increase in seed yield over control was also recorded higher in the treatment of hexaconazole (30.04%) followed by penconazole (26.24%), difenoconazole (24.49%), dinocap (23.73%), wettable sulphur (22.15%) and azoxystrobin (20.51%), respectively.

The economics of different fungicides for the management of powdery mildew of mustard indicates the highest incremental cost benefit ratio (ICBR) of 1:4.63 in four sprays of hexaconazole 0.005 per cent followed by wettable sulphur 0.2 per cent (1:3.36) and penconazole 0.010 per cent (1:1.07).

The mustard crop sprayed with hexaconazole noted maximum oil content of 34.37 per cent followed by penconazole (34.03%), difenoconazole (33.57%), dinocap (33.12%), wettable sulphur (32.99%) and azoxystrobin (32.64%) as compared to no spray control (30.70%). Similarly, the maximum per cent increase in oil content was recorded in the treatment of hexaconazole (11.95%) followed by penconazole (10.85%), difenoconazole (9.35%), dinocap (7.88%), wettable sulphur

(7.46%) and azoxystrobin (6.32%) over no spray control.

The maximum protein content (18.05%) was observed in the treatment of hexaconazole followed by penconazole (17.52%). The next best treatment was difenoconazole (17.29%), dinocap (17.07%) and wettable sulphur (16.84%) as compared to no spray control (14.32%) under pooled results. The maximum per cent increase in protein content was also found in the treatment of hexaconazole (26.05%) followed by penconazole (22.35%), difenoconazole (20.74%), dinocap (19.20%), wettable sulphur (17.60%) and azoxystrobin (17.04%).

Effect of fungicides on 1000 seeds weight of mustard over three years pooled results indicated equally good effect of hexaconazole (5.39 g) followed by penconazole (5.32 g), dinocap (5.25 g), difenoconazole (5.24 g) and wettable sulphur (5.20). Azoxystrobin was the least effective and recorded 5.16 g of 1000 seeds weight over no spray control (4.39 g). Among different treatments tried, maximum per cent increase in 1000 seeds weight was recorded in hexaconazole (22.78%) and least in the treatment of azoxystrobin (17.54%) over no spray control.

In present investigation, foliar sprays of fungicides significantly reduced the intensity of powdery mildew disease under field condition thereby reduced the stress of pathogen on mustard crop. The fungicidal treatments were also found to increase the seed yield of mustard as well as improve the oil and protein content and 1000 seeds weight substantially over water spray and no spray control.

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