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Evaluation of fungicides against spore germination inhibition of *Erysiphe polygoni* DC *in vitro*

KP Anusree and KK Kanzaria

Abstract
A laboratory experiment was conducted at the Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh to study the *in vitro* efficacy of different fungicides against spore germination inhibition of *Erysiphe polygoni* DC causing powdery mildew disease in black gram. The experiment comprises non-systemic, systemic and ready mix fungicides using completely randomized design replicated thrice. The observations were taken after 48, 72 and 96 hours of treatment. The results revealed that, among non-systemic fungicide, wettable sulphur 80% WP found significantly superior over rest of the treatments with a mean spore germination inhibition of 67.31 per cent. Whereas, among systemic fungicides, propiconazole 25% EC remain significantly superior over rest of the treatment with mean spore germination inhibition of 78.80 per cent, but it was remained statistically at par with hexaconazole 5% EC (77.26 per cent). Among ready-mix fungicides, tebuconazole 50% + trifloxystrobin 25% WG found significantly superior over rest of the treatment with mean spore germination inhibition of 88.30 per cent. The fungicides, Kresoxim methyl 15% + chlorothalonil 56% WG and Captan 70% + hexaconazole 5% WP found next effective treatment and remain equally effective with mean spore germination inhibition of 82.01 and 79.97 per cent, respectively.

Keywords: Fungicides, powdery mildew, *Erysiphe polygoni*, black gram

Introduction
Powdery mildew of black gram (*Vigna mungo* (L.) Hepper) caused by *Erysiphe polygoni* DC is one of the major constraints in the successful production under high humid and moderate temperature condition prevails during late *Kharif* season. The disease causes both qualitative and quantitative loss of seeds. Different workers have studied *in vitro* efficacy of fungicides and reported promising results in inhibiting the spore germination inhibition of *E. polygoni*. Meena *et al.* (2019) [7] from Udaipur reported 90.20 per cent inhibition *E. polygoni* of black gram with hexaconazole 5% EC at 0.2% concentration followed by mycobutanil 10% WP and propiconazole 25% EC with germ tube inhibition of 87.13 and 86.08 per cent, respectively using cavity slide technique. Vekariya (2016) [13] reported maximum spore germination inhibition of *E. polygoni* infecting green gram in tebuconazole 55% EC + trifloxystrobin 25% WG at 1500 ppm concentration at Junagadh Agricultural University, Junagadh after 24 hours of incubation period. Similarly, Kavyashree *et al*. (2017) [4] from Dharwad, Karnataka reported cent per cent inhibition of spore germination of *E. polygoni* causing powdery mildew of green gram using tebuconazole 50% + trifloxystrobin 25% WG at 0.15% followed by carbendazim 25% + mancozeb 50% WS with 96.31 per cent inhibition over control. In Saurashtra, the powdery mildew disease is emerging as a serious problem since last few years. Keeping in view the importance of black gram and the severity of the disease, the present work was carried out to know the efficacy of fungicides and results obtained were present here.

Materials and Methods
A laboratory experiment was conducted at the Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh to study the *in vitro* efficacy of different fungicides against spore germination inhibition of *Erysiphe polygoni* DC causing powdery mildew disease in black gram. The experiment comprises seven non-systemic fungicides *viz*., captan 75% WP, chlorothalonil 75% WP, copper oxychloride 50% WP, mancozeb 75% WP, propineb 70% WP, wettable sulphur 80% WP and zineb 75% WP with three concentrations (1000, 1500 and 2000 ppm), seven systemic fungicides *viz*., azoxystrobin 23% SC, carbendazim 50% WP, hexaconazole 5% EC, myclobutanil 10% WP, propiconazole 25% EC, tebuconazole 25.9% EC and thiophanate methyl 70% WP with three concentrations

(100, 250 and 500 ppm) and seven ready-mix fungicides *viz.*, azoxystrobin 18.2% + difenoconazole 11.4% SC, carbendazim 12% + mancozeb 63% WP, captan 70% + hexaconazole 5% WP, kresoxim-methyl 15% + chlorothalonil 56% WG, metiram 55% + pyraclostrobin 5% WG, pyraclostrobin 133 g/l + epoxiconazole 50 g/l SE and tebuconazole 50% and trifloxystrobin 25% WG with three concentrations (500, 750 and 1000 ppm) and were evaluated against test pathogen *E. polygoni* under laboratory condition. Spore germination inhibition activities of these fungicides were tested by Poisoned Food Technique using Potato Dextrose Agar (PDA) as the germinating medium (Bagchi and Das, 1968) [1]. The powdery mildew spores were collected by gently rubbing sterilized camel hair brush on spotted part of leaves. The stock solutions of various fungicides with different level of concentrations were prepared and diluted it to get the required concentration. With micropipette appropriate required quantity of each fungicide was incorporated into autoclaved PDA medium before solidification and then medium was poured into sterilized Petri dishes in equal quantity (5 ml per Petri dish) to form a uniform thin layer. The collected spores were dusted under aseptic conditions over the solidified PDA media. The inoculated Petri dishes were incubated at room temperature for 48 hours and more. The inoculated Petri dish with PDA but without fungicide served as the control. The conidium having germ tube length of more than its width was considered as a germinated conidium. The efficacy of fungicides on inhibition of conidial germination in each treatment was observed at 48, 72 and 96 hours after inoculation with the help of compound microscope. Experiment was laid out with seven treatments and each treatment repeated three times. Completely Randomized block Design with Factorial Concept was used for analyzing the data.

Per cent inhibition of spore germination in each treatment was calculated by using the following formula (Bliss, 1934) [2].

$$I = \frac{C - T}{C} \times 100$$

Where,
I = Percent inhibition
C = Number of germinated spore in control
T = Number of germinated spore in treatment

Results and Discussion

Efficacy of non-systemic fungicides on spore germination inhibition of *E. polygoni* under *in vitro* condition

Seven different non-systemic fungicides were evaluated against the test pathogen *E. polygoni* under laboratory condition by following the spore germination inhibition technique. The observations based on the per cent spore germination inhibition at 48, 72 and 96 hrs are presented in Table 1. It can be concluded from the data that all the seven non-systemic fungicides significantly increased progressive spore germination inhibition of *E. polygoni* after 48, 72 and 96 hours of incubation. It was also noted that the trend of spore germination inhibition increased with the increase in concentration of the fungicides.

Among different fungicides tested, wettable sulphur 80% WP found significantly superior over rest of the treatments with a mean spore germination inhibition of 67.31 per cent. It was also seen that the fungicides mancozeb 75% WP and copper oxychloride 50% WP remained statistically at par with mean spore germination inhibition of 59.67 and 56.48 per cent, respectively. The next effective fungicides in descending order were chlorothalonil 75% WP, propineb 70% WP and captan 75% WP with mean spore germination inhibition of 53.18, 50.42 and 48.00 per cent, respectively. Whereas, zineb 75% WP was found the least effective fungicide among the group with 39.64 per cent mean spore germination inhibition.

At 48 hours of treatment, the fungicide wettable sulphur 80% WP at 0.2 per cent concentration gave 65.20 per cent spore germination inhibition, but it was remained statistically at par with the same fungicide at 0.15 and 0.10 per cent concentration with 63.68 and 62.17 per cent spore germination inhibition followed by mancozeb 75% WP with 59.13 per cent spore germination inhibition. The least effective fungicide with minimum spore germination inhibition of 31.85 per cent was recorded in zineb 75% WP at 0.1 per cent concentration, which was remained statistically at par with the same treatment at 0.15 and 0.2 per cent concentrations with spore germination inhibition of 33.16 and 34.88 per cent, respectively.

Table 1: Efficacy of non-systemic fungicides on spore germination inhibition of *E. polygoni* under *in vitro* condition

Sr. No.	Non-systemic fungicide	Conc. (%)	Per cent spore germination inhibition after			Mean inhibition (%)
			48 Hrs.	72 Hrs.	96 Hrs.	
1.	Captan 75% WP	0.10	38.90(39.43)	41.58 (44.04)	44.69 (49.45)	43.84 (48.00)
		0.15	40.66 (42.46)	44.64 (49.37)	46.71 (52.98)	
		0.20	43.28 (47.01)	45.41 (50.71)	48.74 (56.51)	
2.	Chlorothalonil 75% WP	0.10	43.28 (47.01)	45.41 (50.71)	48.74 (56.51)	46.83 (53.18)
		0.15	44.15 (48.52)	46.94 (53.37)	49.42 (57.69)	
		0.20	45.02 (50.04)	47.70 (54.71)	50.79 (60.04)	
3.	Copper oxychloride 50% WP	0.10	45.02 (50.04)	47.70 (54.71)	50.11 (58.87)	48.73 (56.48)
		0.15	45.89 (51.56)	49.24 (57.38)	50.79 (60.04)	
		0.20	47.63 (54.59)	50.02 (58.71)	52.18 (62.40)	
4.	Mancozeb 75% WP	0.10	47.63 (54.59)	49.24 (57.38)	51.48 (61.22)	50.59 (59.67)
		0.15	48.50 (56.10)	50.02 (58.71)	52.18 (62.40)	
		0.20	50.26 (59.13)	52.36 (62.71)	53.58 (64.75)	
5.	Propineb 70% WP	0.10	41.54 (43.98)	44.64 (49.37)	46.71 (52.98)	45.24 (50.42)
		0.15	42.41 (45.49)	45.41 (50.71)	47.39 (54.16)	
		0.20	44.15 (48.52)	46.17 (52.04)	48.74 (56.51)	
6.	Wettable sulfur 80% WP	0.10	52.04 (62.17)	53.96 (65.38)	56.45 (69.46)	55.15 (67.31)
		0.15	52.94 (63.68)	55.58 (68.05)	57.19 (70.63)	

		0.20	53.85 (65.20)	56.40 (69.38)	57.93 (71.81)	
7.	Zineb 75% WP	0.10	34.36 (31.85)	38.47 (38.70)	41.30 (43.57)	39.09 (39.64)
		0.15	35.28 (33.16)	39.25 (40.03)	42.66 (45.92)	
		0.200	36.20 (34.88)	40.03 (41.37)	43.34 (47.10)	
Mean inhibition (%)			C1	C2	C3	
			45.88 (51.54)	47.03 (53.54)	48.29 (55.73)	
			Fungicide (F)	Concentration (C)	F x C	
S.Em. ±			0.76	0.50	1.32	
C.D at 5%			2.17	1.42	3.76	
C.V.%			4.85			

After 72 hours of treatment, wettable sulphur 80% WP at 0.2 per cent concentration found to have maximum spore germination inhibition of 69.38 per cent, but it was remained at par with its own 0.15 and 0.1 per cent concentrations having a spore germination inhibition of 68.05 and 65.38 per cent, respectively. The least effective fungicide with minimum spore germination inhibition of 38.70 per cent was recorded in zineb 75% WP at 0.1 per cent concentration, which remained statistically at par in its 0.15 and 0.2 per cent concentration with 40.03 and 41.37 percent spore germination inhibition, respectively followed by captan 75% WP at 0.1 per cent concentration with a spore germination inhibition of 44.04 per cent.

The results of 96 hours of treatment also showed that wettable sulphur 80% WP at 0.2 per cent concentration gave maximum spore germination inhibition of 71.81 per cent, but it was remained at par with the same fungicide at 0.15 and 0.1 per cent concentration with 70.63 and 69.46 per cent spore germination inhibition, respectively. The least effective fungicide was zineb 75% WP at 0.1 per cent concentration with a minimum spore germination inhibition of 43.57 per cent which remained statistically at par in its 0.15 and 0.2 per cent concentration with 45.92 and 47.10 percent spore germination inhibition, respectively followed by captan 75% WP at 0.1 per cent concentration with a spore germination inhibition of 49.45 per cent.

From the present observations, it was seen that the sulphur fungicide was highly effective against the target pathogen when compared to other fungicides. Inspite of intensive investigations by many researchers, it is not certain whether sulphur or a compound of sulphur permeates fungous cells and causes toxicity. At first, it was observed that the sulphur could not be the toxic agent. Sempio (1932) [12] reported that the action was due to the production of various sulphur derivatives. Another theory was that the fungal spores reduce sulphur to H_2S which was shown toxic to the spores. Finally, it was certain that sulphur itself is toxic to fungal growth (Lukens, 1971) [5].

The present findings were in accordance with the literature showing effectiveness of wettable sulphur against *Erysiphe polygoni* as given by Chovatiya (2010) [3] and Marakna *et al.* (2020) [6] in fenugreek, Rakhonde *et al*. (2011) [10], Vekariya (2016) [13] and Kavyashree *et al*. (2017) [4] in green gram.

Efficacy of systemic fungicides on spore germination inhibition of *E. polygoni* under *in vitro* condition

Seven different systemic fungicides were tested against *E. polygoni* under the laboratory condition by following the spore germination inhibition technique. The observations based on the per cent spore germination inhibition at 48, 72 and 96 Hrs. are presented in the Table 2.

The results received indicated that all the seven systemic fungicides significantly increased progressive spore germination inhibition of *E. polygoni* after 48, 72 and 96 hours of treatment. It was also evident that the inhibition per cent increased with the increase in concentration of the fungicides.

Among different systemic fungicides tested *in vitro*, propiconazole 25% EC was found significantly superior over rest of the treatment with mean spore germination inhibition of 78.80 per cent, but it was remained statistically at par with hexaconazole 5% EC with mean spore germination inhibition per cent of 77.26. The next effective fungicide with mean spore germination inhibition of 70.27 per cent was myclobutanil 10% WP. The moderately effective fungicides found were carbendazim 50% WP and tebuconazole 25.9% EC with 61.59 and 50.44 per cent mean spore germination inhibition, respectively. Whereas, the least effective fungicide among the group with 46.00 per cent mean spore germination inhibition was azoxystrobin 23% SC which was remained at par with thiophanate methyl 70% WP with a mean spore germination inhibition of 48.60 per cent.

Table 2: Efficacy of systemic fungicides on spore germination inhibition of *E. polygoni* under *in vitro* condition

Sr. No.	Systemic fungicide	Conc. (%)	Per cent spore germination inhibition after			Mean inhibition (%)
			48 Hrs.	72 Hrs.	96 Hrs.	
1.	Azoxystrobin 23% SC	0.010	35.86 (34.32)	40.71 (42.54)	43.11 (46.70)	42.68 (46.00)
		0.025	38.41 (38.60)	42.87 (46.29)	44.39 (48.93)	
		0.050	44.20 (48.61)	45.74 (51.29)	48.86 (56.71)	
2.	Carbendazim 50% WP	0.010	47.48 (54.33)	50.06 (58.79)	50.79 (60.40)	51.74 (61.59)
		0.025	48.31 (55.76)	50.79 (60.04)	52.10 (62.27)	
		0.050	53.33 (64.33)	55.27 (67.55)	57.52 (71.16)	
3.	Hexaconazole 5% EC	0.010	55.05 (67.19)	57.60 (71.30)	58.22 (72.27)	61.66 (77.26)
		0.025	62.46 (78.62)	62.58 (78.80)	64.27 (81.16)	
		0.050	63.47 (80.04)	65.30 (82.54)	65.94 (83.38)	
4.	Myclobutanil 10% WP	0.010	53.33 (64.33)	56.04 (68.80)	56.13 (68.93)	56.99 (70.27)
		0.025	55.05 (67.19)	56.82 (70.05)	58.22(72.27)	
		0.050	57.72 (71.47)	59.21 (73.80)	60.40 (75.60)	
5.	Propiconazole 25% EC	0.010	56.82 (70.05)	57.60 (71.30)	59.66 (74.49)	62.74 (78.80)

		0.025	62.46 (78.62)	64.37 (81.29)	65.10 (82.27)	
		0.050	65.57 (82.90)	66.26 (83.79)	66.80 (84.49)	
6.	Tebuconazole 25.9% EC	0.010	40.91 (43.89)	45.02 (50.04)	46.94 (53.37)	45.25 (50.44)
		0.025	41.74 (44.32)	45.74 (51.29)	47.57 (54.49)	
		0.050	43.38 (47.18)	46.46 (52.54)	49.50 (57.82)	
7.	Thiophanate methyl 70% WP	0.010	39.25 (40.03)	42.87 (46.29)	46.30 (52.26)	44.19 (48.60)
		0.025	40.91 (42.89)	43.59 (47.54)	46.94 (53.37)	
		0.050	42.56 (45.75)	46.46 (52.54)	48.86 (56.71)	
Mean inhibition (%)			C1	C2	C3	
			49.51 (57.84)	52.13 (62.31)	54.90 (66.93)	
			Fungicide (F)	Concentration (C)	F x C	
S.Em. ±			0.78	0.51	1.36	
C.D at 5%			2.24	1.46	3.87	
C.V.%			4.51			

At 48 hours of treatment, propiconazole 25% EC at 0.05 per cent concentration gave maximum spore germination inhibition of 82.90 per cent but it was remained statistically at par with hexaconazole 5% EC at same concentration with spore germination inhibition of 80.04 per cent followed by hexaconazole 5% EC and propiconazole 25% EC at the same concentration of 0.025 per cent with 78.62 per cent spore germination inhibition. The least effective fungicide with minimum spore germination inhibition of 34.32 per cent was recorded in azoxystrobin 23% SC at 0.01 per cent concentration, which was remained statistically at par with its 0.025 per cent concentration and gave spore germination inhibition of 38.60 per cent followed by thiophanate methyl 70% WP at 0.01 per cent concentration with spore germination inhibition of 40.03 per cent.

The fungicide propiconazole 25% EC at 0.05 per cent concentration gave maximum spore germination inhibition of 83.79 per cent, but it was remained statistically at par with hexaconazole 5% EC at 0.05 concentration with spore germination inhibition of 82.54 per cent followed by propiconazole 25% EC and hexaconazole 5% EC each at 0.025 concentration with 81.29 and 78.80 per cent spore germination inhibition, respectively after 72 hours of treatment. The least effective fungicide with minimum spore germination inhibition of 42.54 per cent was recorded in azoxystrobin 23% SC at 0.01 per cent concentration, but it was remained statistically at par in its 0.025 per cent concentration followed by thiophanate methyl 70% WP at 0.01 per cent concentration with same spore germination inhibition of 46.29 per cent and thiophanate methyl 70% WP at 0.025 per cent concentration with spore germination inhibition of 47.54 per cent.

After 96 hours of treatment, results showed that propiconazole 25% EC at 0.05 per cent concentration gave maximum spore germination inhibition of 84.49 per cent, but it was remained statistically at par with hexaconazole 5% EC at 0.05 per cent concentration with spore germination inhibition of 83.38 per cent followed by propiconazole 25% EC and hexaconazole 5% EC at the same concentration of 0.025 per cent with spore germination inhibition of 82.27 and 81.16 per cent, respectively. The least effective fungicide with minimum spore germination inhibition of 46.70 per cent was recorded in azoxystrobin 23% SC at 0.01 per cent concentration, but it was remained statistically at par in its 0.025 per cent concentration with spore germination inhibition of 48.93 per cent followed by thiophanate methyl 70% WP at 0.01 and 0.025 per cent concentration and tebuconazole 25.9% EC at 0.01 per cent concentration with spore germination inhibition of 52.56, 53.37 and 53.37 per cent, respectively.

Among the different systemic fungicides, it was evident that the triazole group of fungicides *viz*., propiconazole, hexaconazole and myclobutanil were the most effective of all the treatments. Their accepted mode of action entails inhibition of one specific enzyme, C14-demethylase which plays a role in sterol production such as ergosterol needed for membrane structure and function, making them essential for the development of functional cell walls. Therefore, these fungicides result in abnormal fungal growth and eventually death (Mueller, 2006) [8]. Moreover, they hamper conidial and haustoria formation. They change the sterol content and saturation of the polar fatty acids leading to alterations in membrane permeability and behaviour of membrane bound enzymes (Nene and Thapliyal, 1993) [9].

The results so obtained is supported by the literatures describing the effectiveness of triazoles in controlling black gram powdery mildew caused by *E. polygoni* given by Meena *et al.* (2019) [7]. The superiority of propiconazole and hexaconazole in controlling powdery mildew was seen in experiments conducted by Vekariya (2016) [13] in green gram and Marakna *et al*. (2020) [6] in fenugreek. Kavyashree *et al*. (2017) [4] also found the effective action of hexaconazole in controlling green gram powdery mildew caused by *E. polygoni*.

Efficacy of ready-mix fungicides on spore germination inhibition of *E. polygoni* under *in vitro* condition

Efficacy of seven ready-mix fungicides against spore germination inhibition of *E. polygoni,* were evaluated using spore germination inhibition technique. The results obtained on per cent spore germination inhibition at 48, 72 and 96 hrs of treatment are presented in the Table 3. The results deduced that in the majority of cases all the seven fungicides had an increased cumulative spore germination inhibition of *E. polygoni* after 48, 72 and 96 hrs of treatment. It is also visualised that inhibition per cent increased somewhat with the increase in concentration of the fungicides.

Among different seven ready-mix fungicides, tebuconazole 50% + trifloxystrobin 25% WG found significantly superior over rest of the treatment with mean spore germination inhibition of 88.30 per cent. The fungicides, kresoxim methyl 15% + chlorothalonil 56% WG and captan 70% + hexaconazole 5% WP remain equally effective with mean spore germination inhibition of 82.01 and 79.97 per cent, respectively. The next effective fungicide was carbendazim 12% + mancozeb 63% WP with mean spore germination inhibition of 74.54 per cent. The fungicides, pyraclostrobin 133 g/l + epoxiconazole 50 g/l SE and azoxystrobin 18.2% +

difenoconazole 11.4% SC remain equally effective with mean spore germination inhibition of 69.08 and 67.25 per cent, respectively. Whereas, the least effective fungicide among the group with 62.76 per cent mean spore germination inhibition was noticed in metiram 55% + pyraclostrobin 5% WG.

At 48 hours of treatment, tebuconazole 50% + trifloxystrobin 25% WG at 0.1 per cent concentration found most effective and gave maximum spore germination inhibition of 88.61 per cent, but it was remained statistically at par with the same fungicide at 0.075 and 0.05 per cent concentration with 87.18 and 85.76 per cent spore germination inhibition, respectively. The least effective treatment among the ready-mix fungicides with minimum spore germination inhibition of 57.19 per cent was observed in metiram 55% + pyraclostrobin 5% WG, but it was remained statistically at par with the same fungicide at 0.075 and 0.1 per cent concentration with 58.61 and 60.04 per cent spore germination inhibition, respectively, followed by azoxystrobin 18.2% + difenoconazole 11.4% SC at 0.05 per cent concentration with spore germination inhibition of 61.47 per cent.

The observations taken after 72 hours of treatment also recorded the maximum spore germination inhibition per cent of 90.04 in tebuconazole 50% + trifloxystrobin 25% WG at 0.1 per cent concentration, but it was remained statistically at par with the same fungicide at 0.075 and 0.05 per cent concentration with 88.79 and 87.54 per cent spore germination inhibition, respectively. Whereas, metiram 55% + pyraclostrobin 5% WG at 0.05 per cent concentration was found the least effective fungicide with a minimum spore germination inhibition of 61.29 per cent, but it was remained statistically at par with the same fungicide at 0.075 and 0.1 per cent concentration with 62.54 and 65.05 per cent spore germination inhibition, respectively, followed by azoxystrobin 18.2% + difenoconazole 11.4% SC and pyraclostrobin 133 g/l + epoxiconazole50 g/l SE with 66.30 per cent spore germination inhibition at 0.05 per cent concentration.

After 96 hours of treatment, the maximum spore germination inhibition of 90.04 per cent was noticed in tebuconazole 50% + trifloxystrobin 25% WG at 0.1 per cent concentration, but it was remained statistically at par with the same fungicide at 0.075 and 0.05 per cent concentration with 88.93 and 87.82 per cent spore germination inhibition, respectively, followed by captan 70% + hexaconazole 5% WP with 86.71 per cent spore germination inhibition at 0.1 per cent concentration. The least effective fungicide in the group with minimum spore germination inhibition of 65.60 per cent was found in metiram 55% + pyraclostrobin 5% WG at 0.05 per cent concentration, but it was remained statistically at par with the same fungicide at 0.075 and 0.1 per cent concentration with 66.71 and 67.82 per cent spore germination inhibition, respectively, followed by azoxystrobin 18.2% + difenoconazole 11.4% SC at 0.05 and 0.075 per cent concentration with 68.93 and 70.05 per cent spore germination inhibition, respectively and pyraclostrobin 133 g/l + epoxiconazole 50 g/l SE at 0.05 per cent concentration with spore germination inhibition of 70.05 per cent.

The ready-mix fungicides have a mode of action of two different groups of fungicides. As a result of this combined action, tebuconazole 50% + trifloxystrobin 25% WG was said to have the effect of both triazole and strobilurin group of fungicides. The triazole group interfere with the biosynthesis of ergosterol. The strobilurins act on fungal mitochondrial respiration, causing electron transport blockage in the cytochrome bc1 complex (complex III of electron transport chain), between cytochrome b and cytochrome c1, at the Qo site by inhibiting ubiquinol-cytochrome c-oxide reductase. They obstruct the respiratory process by hindering the fungus cell’s energy supply (ATP), leading to its death, thus, they are also known as QoIs or inhibitors of the bc1 complex (Selim and Khalil, 2021) [11].

The present findings are in close conformity with the results demonstrated by Vekariya (2016) [13] and Kavyashree *et al*. (2017) [4]. They described the efficiency of tebuconazole 50% + trifloxystrobin 25% WG in controlling green gram powdery mildew caused by *E. polygoni*. Marakna *et al*. (2020) [6] also reported similar type of results while working with fenugreek powdery mildew caused by *E. polygoni*.

Table 3: Efficacy of ready-mix fungicides on spore germination inhibition of *E. polygoni* under *in vitro* condition

Sr. No.	Ready-mix fungicide	Concentration (%)	Per cent spore germination inhibition after 48 Hrs.	72 Hrs.	96 Hrs.	Mean inhibition (%)
1.	Azoxystrobin 18.2% + Difenoconazole 11.4% SC	0.050	51.63(61.47)	54.51 (66.30)	56.13 (68.93)	55.12 (67.25)
		0.075	52.48 (62.90)	55.27 (67.55)	56.82 (70.05)	
		0.100	54.19 (65.76)	56.82 (70.05)	58.22 (72.27)	
2.	Carbendazim 12% + Mancozeb 63% WP	0.050	55.93 (68.62)	57.60 (71.30)	59.66 (74.49)	59.74 (74.54)
		0.075	58.63 (72.90)	60.03 (75.05)	62.68 (78.93)	
		0.100	59.56 (74.33)	60.86 (76.30)	62.68 (78.93)	
3.	Captan 70% + Hexaconazole 5% WP	0.050	59.56 (74.33)	61.71 (77.55)	62.68 (78.93)	63.50 (79.97)
		0.075	61.47 (77.19)	63.47 (80.04)	64.27 (81.16)	
		0.100	63.47 (80.04)	66.26 (83.79)	68.62 (86.71)	
4.	Kresoxim methyl 15% + Chlorothalonil 56% WG	0.050	62.46 (78.62)	62.58 (78.80)	64.27 (81.16)	64.95 (82.01)
		0.075	63.47 (80.04)	65.30 (82.54)	65.94 (83.38)	
		0.100	65.57 (82.90)	67.25 (85.04)	67.70 (85.60)	
5.	Metiram 55% + Pyraclostrobin 5% WG	0.050	49.13 (57.19)	51.53 (61.29)	54.09 (65.60)	52.41 (62.76)
		0.075	49.96 (58.61)	52.27 (62.54)	54.76 (66.71)	
		0.100	50.79 (60.04)	53.76 (65.05)	55.44 (67.82)	
6.	Pyraclostrobin 133g/l + Epoxiconazole 50g/l SE	0.050	52.48 (62.90)	54.51 (66.30)	56.82 (70.05)	56.25 (69.08)
		0.075	54.19 (65.76)	56.04 (68.30)	58.22 (72.27)	
		0.100	55.93 (68.62)	58.40 (72.55)	59.66 (74.49)	
7.	Tebuconazole 50% + Trifloxystrobin 25%WG	0.050	67.83 (85.76)	69.33 (87.54)	69.57 (87.82)	70.03 (88.30)
		0.075	69.02 (87.18)	70.44 (88.79)	70.56 (88.93)	
		0.100	70.28 (88.61)	71.60 (90.04)	71.60 (90.04)	

Mean inhibition (%)	C1	C2	C3
	58.76 (73.11)	60.25 (75.38)	61.84 (77.73)
	Fungicide (F)	Concentration (C)	F x C
S.Em. ±	0.62	0.4	1.07
C.D at 5%	1.76	1.75	3.04
C.V.%	3.06		

Conclusion

Fungicides play an important role in inhibiting the spore germination of *Erysiphe polygoni* DC effectively. The results indicated that all the fungicides were effective in inhibiting the spore germination of *E. polygoni* as compared to control. It was also evident that the per spore germination inhibition increases with increase in concentration of fungicides at 48, 72 and 96 hours of treatment. Among the non-systemic fungicides, wettable sulphur 80% WP, among systemic fungicides, propiconazole 25% EC and hexaconazole 5% EC and in the ready-mix group, tebuconazole 50% + trifloxystrobin 25% WG remained very effective in inhibiting the spore germination of *E. polygoni* under *in vitro* condition.

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