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Efficacy of fungicides against powdery mildew of pea caused by *Erysiphe polygoni* DC

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Abstract
Pea (*Pisum sativum* L.) occupies a prominent place in the vegetable cultivars in India. Powdery mildew disease on pea (*Pisum sativum* L.) incited by fungus *Erysiphe polygoni* DC is an important limiting factor in pea cultivation in Western Maharashtra. The study was undertaken under field conditions to evaluate the efficacy of five fungicides against powdery mildew of pea incited by *Erysiphe polygoni* DC. All the spray treatments were found effective against the disease and significantly reduced the powdery mildew intensity and thereby increased the seed yield and in pea cv. Arkel over unsprayed control. Among the six fungicide evaluated under field conditions, three sprays of Hexaconazole and Propiconazole was found more effective in reducing disease severity and yield which was at par with each other.

Keywords: powdery mildew, *Erysiphe polygoni* Dc, *Pisum sativum,* fungicides

Introduction
Pea (*Pisum sativum* L.) is one of the most popular vegetable crop grown throughout the county. Pea crop is severely affected with powdery mildew disease incited by *Erysiphe polygoni* DC. Most of the pea cultivars presently under cultivation are highly susceptible to the disease. The disease can cause 25–50 percent yield losses (Munjal *et al*. 1963; Warkentin *et al*. 1996) [2, 8], the reduction in number of pods per plant is estimated to be 28.6 percent, reducing total yield biomass, number of pods per plant, number of seeds per pod, plant height and number of nodes.

A single method of control may not be complete to manage this disease effectively. Hence, it is important to develop suitable disease Management practices like effect of foliar sprays of fungicides**.**

Material and Methodology
The field trials were conducted during *rabi* 2016-17 and *rabi* 2017-18 crop seasons, in Randomized Block Design (RBD) with three replications. The size of each plot was 2.70 x 3.40 m^2, row to row distance was maintained at 30 cm, plant to plant distance was maintained at 15 cm. Cultivar of pea was sown on 15 October. Fertilizer basal dose 15: 60: 60 kg N: P: K per hectare was applied before sowing. After one month of sowing top dressing of 10 kg N per hectare was given. Sprayed Dimethoate @ 0.1 % twice on the crop to prevent the crop damage from pea leaf miner and pod borer and other foliage and stem feeding insects. Crop was sprayed thrice with each fungicides at their recommended doses. Six fungicides *viz.*, Dinocap 48 EC (0.1%), Hexaconazole 5 EC (0.5%), Tebuconazole 25 EC (0.1%), Propiconazole 25 EC (0.1%), Wettable sulphur 80% WP (0.2%), Tridemefon (0.1%). First spraying was done at the onset of disease symptoms and repeated after 10 days interval. Three sprays of each solution was given, first at 50 days after sowing, second at 60 days after sowing and third at 70 days after sowing during *rabi* season of the year 2016-17 and 2017-18. Control plots were sprayed with same volume of water. Disease severity was recorded before the beginning of first spray and subsequent observations were recorded before each spray and finally disease severity was recorded 10 days after last spray. Before harvesting ten plants were selected randomly from each plot and number of pods and total number of grains per pod were counted. Pod yield (kg/plot) was also recorded and finally converted in to qtl/ha. Data was statistically analyzed.

Numerical grades were assigned to the amount of disease observed applying 0-9 disease rating scale given by (Mayee and Datar, 1986) [1] and further these scales were converted to per cent disease index using formula. Green p converted in to qt/ha. The data recorded was statistically analyzed. ND OD yield (kg/ha) from each plot was recorded and finally converted in to qt/ha. The data recorded was statistically analyzed.

$$PDI = \frac{\text{Total sum of numerical rating}}{\text{No. of leaves examined}} \times \frac{100}{\text{Maximum grade value}}$$

Further, per cent disease control (PDC) was worked out by applying the formula:

$$PDC = \frac{\text{PDI in control plot} - \text{PDI in treated plot}}{\text{PDI in control plot}} \times 100$$

Result and Discussion

Effect of foliar spray of fungicides on powdery mildew severity and green pod yield during *rabi* 2016-17 and 2017-18

The effect of foliar sprays of different fungicides on powdery mildew severity, yield parameters and green pod yield during 2016-17 and 2017-18 crop season are presented in Table 1 and Table 2 and Fig.1 and 2.

a. Disease severity (%)

The data on powdery mildew severity during 2016-17 crop season indicates that all the fungicides resulted in significant decrease in powdery mildew severity during 2016-17 crop season in Table 1 and Fig. 1 as compared to control.

The disease severity recorded after first spray (50 DAS) indicates statistically significant over control. Minimum disease severity 15.84 per cent was observed in the plot which was protected with Hexaconazole which was followed by Propiconazole (17.12%) and Wetable sulphur (17.22%), respectively. While maximum disease severity 31.67 per cent was recorded in control plot. The disease severity recorded after second spray (60 DAS) was also indicated statistically significance over control. It was revealed that the minimum severity 17.57 per cent was recorded in the plots protected with Hexaconazole which was followed by Propiconazole (21.30%) and Wetable sulphur (21.98%), respectively. While, maximum disease severity 49.14 per cent was recorded in control plot. Similarly, the disease severity recorded after third spray (70 DAS) at the time of maturity was indicated statistically significance over control. It was revealed that, the minimum severity 19.08 per cent was recorded in the plots protected with Hexaconazole which was followed by Propiconazole (25.53%), Wetable sulphur (26.03%), respectively. While, maximum disease severity 77.78 per cent was recorded in control plot.

The data on powdery mildew severity on pea plants during 2017-18 (Table 2. and Fig. 2) followed the same pattern as recorded during previous crop season. The disease severity recorded after first spray (50 DAS) indicates statistically significant over control. Minimum disease severity 16.12 per cent was observed in the plots which was protected with Hexaconazole which was at par with Propiconazole (17.26%), followed by Wetable sulphur (18.17%) and Dinocap (18.55%), respectively. While maximum disease severity 32.59 per cent was recorded in control plot. The disease severity recorded after second spray (60 DAS) was also indicated statistically significance over control. It was revealed that the minimum severity 17.80 per cent was recorded in the plots protected with Hexaconazole which was at par with Propiconazole (21.53%), followed by Wetable sulphur (23.10%) and Tridemefon (23.58%), respectively. While, maximum disease severity 50.40 per cent was recorded in control plot. Similarly, the disease severity recorded after third spray (70 DAS) at the time of maturity was indicated statistically significance over control. It was revealed that, the minimum severity 20.33 per cent was recorded in the plots protected with Hexaconazole which was followed by Propiconazole (25.81%) and Wetable sulphur (26.89%), respectively. While, maximum disease severity 80.86 per cent was recorded in control plot.

A perusal of the data of the effect of fungicide on powdery mildew severity under field conditions indicates that the number of sprays has no effect on powdery mildew severity and only non-significant increase in disease severity was observed when the number of sprays was increased.

b. Grain/pod

The sprays of fungicide resulted in significant increase in a number of grains/pod during the crop seasons. During 2016-17 crop season maximum number of grains/pod 7.50 was recorded in the plots protected with Hexaconazole which was at par with Propiconazole (7.00 grains/pod) and followed by Wetable sulphur (6.50 grains/pod), respectively. While, minimum number of grain/pod 5.00 recorded in a control plot. During 2017-18 crop season maximum number of grains/pod 7.75 was recorded in the plots protected with Hexaconazole which was at par with Propiconazole (7.00 grains/pod), Wetable sulphur (6.75 grains/pod), respectively. While, minimum number of grain/pod 5.25 recorded in a control plot.

c. Pods/plants

Mean values in relation to number of pods/plant indicate that foliar sprays of all fungicides increased the number of pods/plant significantly during crop seasons. During 2016-17 crop season, maximum number of pods/plant 54.5 was recorded in plots sprayed thrice with Hexaconazole which was at par with three foliar spray of Propiconazole (53.00 pods/plant), Tridemefon (52.70 pods/plant), respectively. While, minimum number of pod/plant 33.00 recorded in a control plot. Similar observations were recorded during 2017-18 crop season. Maximum number of pods/plant 54.25 was recorded in plots sprayed thrice with Hexaconazole which was at par with three foliar spray of Propiconazole (54.00 pods/plant), Wetable sulphur (51.25 pods/plant), respectively. While, minimum number of pod/plant 32.50 recorded in a control plot.

d. Green pod yield (qt/ha)

The data pertinent to pod yield (qt/ha) as affected by foliar sprays of fungicides during 2016-17 and 2017-18 crop season revealed that all the fungicide treatments resulted in significant increase in pod yield as compared to control.

Among the fungicides evaluated, three spray of Hexaconazole resulted in maximum pod yield 88.80 qt/ha which was at par with three foliar spray of Propiconazole (86.60 qt/ha). While, minimum pod yield 66.45 qt/ha was recorded in control plot during 2016-17. Similar observations regarding yield were recorded during 2017-18 crop season. Three spray of Hexaconazole resulted in maximum pod yield 86.60 qt/ha which was at par with three foliar spray of Propiconazole (84.20 qt/ha. While, minimum pod yield 64.63 qt/ha was recorded in control plot Singh (2006), Singh (2007) [5], noticed that Contaf 5 EC (Hexaconazole @ 0.1 %) was the most effective fungicide against Powdery mildew diseases. Among the other fungicides, Tridemefon and Dinocap was found effective followed by Wetable sulphur in reducing Powdery mildew severity and were statistically at par with each other during both season. Singh and Singh (1978) [4] found that the sulphur and dinocap formulations have been successfully applied in protective schedules. All the results are in accordance to those reported by Surwase *et al*. (2009) [7], Warkentin *et al*., (1996) [8], Narkhede *et al*., (2007) [3].

The effect of foliar spray of fungicides on number of grain per pods and number of pod per plants was significantly increased during both the crop season with foliar spray of all fungicide. Maximum pod yield was recorded with three foliar spray of Hexaconazole followed by Propiconazole during both the crop seasons. Suryawanshi *et al*., (2006) [7] evaluated seven fungicides for management of powdery mildew of mungbean. All fungicides reduced the powdery mildew incidence with increased yield.

Table 1: Effect of foliar spray of fungicides on powdery mildew severity and green pod yield of pea during the year 2016-17

Treatment	PDI before Ist spray	PDI after spray			Mean PDI	PDC after spray			Mean PDC	Grain/ pods	Pods/ plant	Yield (qt/ha)
		50 DAS	60 DAS	70 DAS		50 DAS	60 DAS	70 DAS				
Dinocap (@ 0.1%)	7.22 (15.58)	18.91 (25.78)	23.39 (28.92)	29.63 (32.98)	24.31	40.3	52.4	61.9	51.53	6.00	48.7	72.72
Tebuconazole (@ 0.1%)	9.33 (17.79)	19.55 (26.24)	24.04 (29.34)	31.28 (37.00)	24.95	38.3	51.1	59.8	49.73	5.75	36.5	71.62
Hexaconazole (@ 0.1%)	7.50 (15.89)	15.84 (23.45)	17.57 (24.78)	19.08 (25.90)	17.49	50.0	64.2	75.5	63.23	7.50	54.5	88.80
Propiconazole (@ 0.1%)	8.37 (16.80)	17.12 (24.43)	21.30 (27.44)	25.53 (30.34)	21.31	46.0	56.6	67.2	56.6	7.00	53.0	86.60
Wetable sulphur (@ 0.2%)	8.12 (16.54)	17.22 (24.52)	21.98 (27.95)	26.03 (30.67)	21.74	45.6	55.3	66.5	55.8	6.50	52.7	74.35
Tridemefon (@ 0.1%)	9.25 (17.70)	18.05 (25.14)	22.79 (28.51)	26.50 (30.98)	22.44	43.0	53.6	65.9	54.16	6.25	49.5	74.28
Control	7.67 (16.04)	31.67 (34.25)	49.14 (44.50)	77.78 (61.88)	52.86	0.0	0.0	0.0	00	5.00	33.0	66.45
SE±	0.343	0.206	0.631	0.270	-	-	-	-	-	0.22	0.79	2.02
CD at 5%	1.020	0.612	1.877	0.803	-	-	-	-	-	0.65	2.35	6.02
CV %	4.131	1.570	4.183	1.534	-	-	-	-	-	7.01	3.37	5.30

Figures in parenthesis are arc sin transformed values

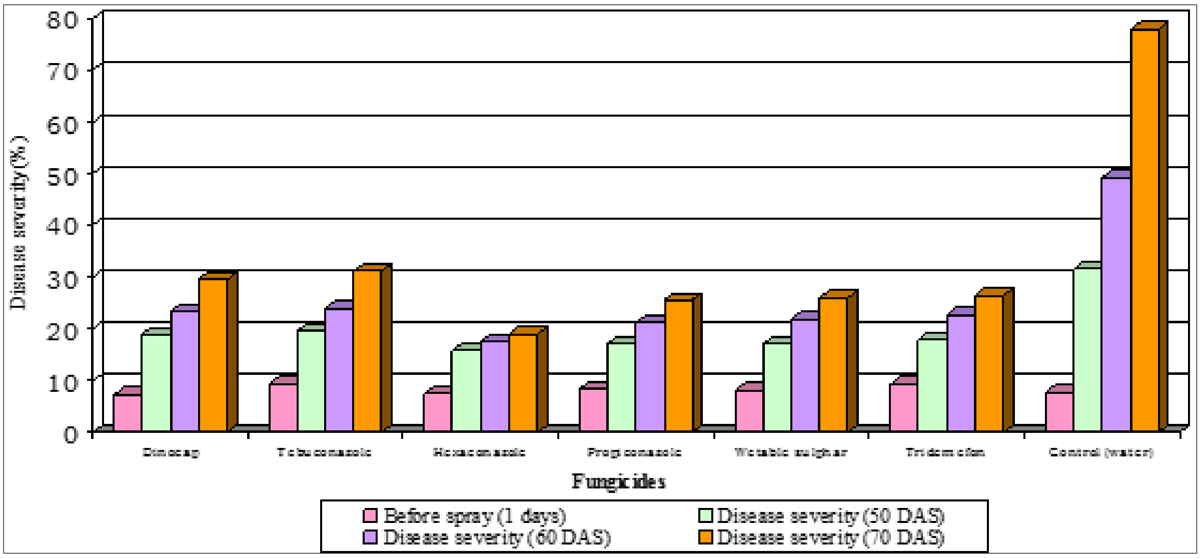

Fig 1: Effect of foliar spray of fungicides on powdery mildew severity during *rabi* 2016-17

Table 2: Effect of foliar spray of fungicides on powdery mildew severity and green pod yield of pea during the year 2017-18

Treatment	PDI before Ist spray	PDI after spray			Mean PDI	PDC after spray			Mean PDC	Grain/ pods	Pods/ plant	Yield (qt/ha)
		50 DAS	60 DAS	70 DAS		50 DAS	60 DAS	70 DAS				
Dinocap (@ 0.1%)	7.47 (15.85)	19.06 (25.88)	24.45 (29.63)	31.55 (34.17)	25.02	41.5	51.5	61.0	51.33	6.25	47.25	71.33
Tebuconazole (@ 0.1%)	9.31 (17.76)	20.31 (26.78)	25.36 (30.23)	31.70 (34.26)	25.79	37.7	49.7	60.8	49.40	5.75	35.75	69.99
Hexaconazole (@ 0.1%)	7.35 (15.73)	16.12 (23.67)	17.80 (24.95)	20.33 (26.78)	18.08	50.5	64.7	74.9	63.36	7.75	54.25	86.60
Propiconazole (@ 0.1%)	8.51 (16.94)	17.26 (24.54)	21.53 (27.59)	25.81 (30.53)	21.53	47.0	57.3	68.1	57.46	7.00	54.00	84.20
Wetable sulphur (@ 0.2%)	9.33 (17.73)	18.17 (25.23)	23.10 (28.72)	26.89 (31.23)	22.72	44.2	54.2	66.7	55.03	6.75	51.25	74.00
Tridemefon (@ 0.1%)	10.05 (18.47)	18.55 (25.50)	23.58 (29.05)	27.45 (31.59)	23.19	43.1	53.2	66.1	54.13	6.25	48.50	72.07
Control	7.86 (16.26)	32.59 (34.81)	50.40 (45.23)	80.86 (64.11)	54.61	0.0	0.0	0.0	00	5.25	32.50	64.63
SE±	0.266	0.576	0.576	0.597	-	-	-	-	-	0.33	1.08	1.71
CD at 5%	0.792	1.713	1.713	1.773	-	-	-	-	-	0.99	3.20	5.07
CV %	5.763	2.003	3.747	3.307	-	-	-	-	-	10.3	4.66	4.57

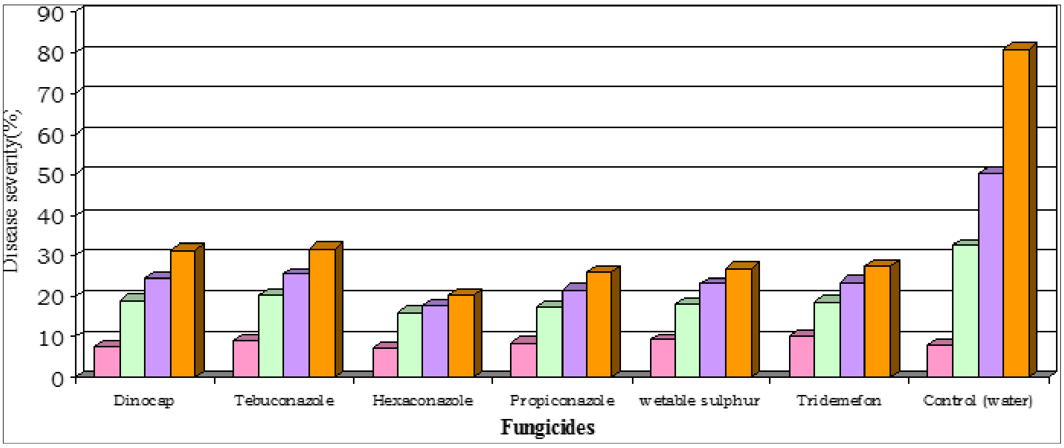

Fig 2: Effect of foliar spray of fungicides on powdery mildew severity during *rabi* 2017-18

Conclusions

Among the six fungicide evaluated under field conditions, three sprays of Hexaconazole and Propiconazole was found more effective in reducing disease severity and yield which was at par with each other.

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