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Assessment of different fungicides against rust (*Uromyces fabae* de Bary) disease of field pea (*Pisum sativum* L.)

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Abstract
The present study was conducted during *Rabi* season of year 2017-18 at the experimental field of JNKVV, Jabalpur (M.P.) for assessment of different fungicides in controlling rust disease of field pea. Seven treatments including control with three replications were taken up by using RBD. Treatments of foliar spray of propiconazole (Tilt 25% EC) @ 0.1% (T1), tebuconazole (Folicure 25.9% EC) @ 0.17% (T2), difenoconazole (Score 25% EC) @ 0.06% (T3), hexaconazole (Contaf plus 5% SC) @ 0.2% (T4), azoxystrobin (Amistar 23% SC) @ 0.1% (T5), carbendazim + mancozeb (Saaf 75% WP) @ 0.2% (T6) and control (Spray of plain water)- T7, were applied at the first initiation of disease symptoms and second at 15 days after the first spray. The data were recorded at 15 and 30 days after the spray. Results showed that the per cent disease intensity (PDI) was significantly low (11.40 and 14.96%) in Propiconazole 25% (EC), followed by Difenoconazole 25% (EC) with 14.66 and 16.09 per cent, respectively. The highest seed yield was recorded in Propiconazole 25% (EC) sprayed plot 19.61 q/ha, followed by Difenoconazole 25% (EC) with 19.40 q/ha, respectively as compared to control which recorded maximum per cent disease intensity (28.74 and 39.85%) and lowest yield 13.75 q/ha.

Keywords: Efficacy, fungicides, *Uromyces fabae*, pea, *Rabi*, per cent

Introduction
Pea is an important crop because of their diversity of utilization and extensive production area (Boros and Wawer, 2009) [6]. Pea is an excellent source of protein, fiber, minerals and vitamins (McPhee, 2004 and Corre-Hellou and Crozat, 2005) [17, 8]. One pound of green peas contains 13.7 g fat, 36.1 g carbohydrates, 45 mg calcium, 249 mg phosphorus and 54 mg ascorbic acid (Khan, 1994) [13]. Pea seed is a source of vitamins A, B, C and contains 35-40 per cent starch and 4-7 per cent fiber. This makes it an appropriate dietary complement to cereals (Dhama *et al*., 2010) [10]. Beside this, peas are harvested at physiological maturity providing forage for animal feed (Borreani *et al*., 2007) [7]. Addition to their ability to fix atmospheric N, peas enhance soil structure and provide breaks for disease control which means they have an important role in modern agricultural systems (McPhee, 2004 and Martin *et al*., 2008) [17, 15]. The total cultivated dry pea area in the world is about 6.2 M ha with an average yield of 1.68 t ha-1 producing an estimated 105 M t. Half of this production is used for livestock feed, and the remaining half for human consumption, mainly in developing countries (Martin-Sanz *et al*., 2011) [16]. In India, pea is grown over an area of 0.77 million hectare with a production 0.71 million tonnes and productivity 915 kg/ha (Singh, 2008) [19]. Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Orissa, Bihar, Rajasthan, Punjab, Haryana and Uttarakhand are major pea growing state in India. The average yield in major pea growing countries. *viz.*, France (15.5 q ha-1), Hungary (15.5 q ha-1) and Netherland (14.3 q ha-1) (Anonymous, 2002) [3], while in India the average yield is 9.15 q ha-1 (Singh, 2008) [19]. The wide gap between the attainable yield potentials and farmers field are due to various biotic, a biotic and socio-economic factors. Despite the potential for pea crops in agriculture, they still face challenges due to competition from weeds, insect attack, disease incidence, instability of productivity and a lack of successful nodulation (Date, 2000; Lemerle *et al.*, 2006 and Martin-Sanz *et al*., 2011) [9, 14, 16]. Rust is one of the most important fungal foliar disease of pea in India, which regularly appears in mild to severe form every year especially in late in season, reaching maximum intensity during the pod formation stage (Gupta *et al*., 1990) [12]. Singh and Tripathi (2004) [20] have also concluded that rust is one of the major disease of field pea and it is responsible for substantial losses in grain yield. Many researchers tried to control this disease chemically worldwide (Rahman *et al.*, 2005; Ahmed *et al.*, 2006) [18].

The disease can be controlled by applying a number of management strategies including biological, cultural, chemical and planting resistant varieties. Among these, use of resistant varieties and application of fungicides are more effective. Considering above point, this study was undertaken at the experimental field of JNKVV, Jabalpur (M.P.) for assessment of different fungicides in controlling rust disease of field pea.

Materials and Methods

The study of the efficacy of six different fungicides was tested against rust disease of field pea at the experimental field of JNKVV, Jabalpur (M.P.) during *Rabi* season of 2017-18. The experiment was planned in Randomized Block Design (RBD) with three replications and there are seven treatments including untreated control. The unit plot size was 3 x 2 m^2. The six fungicides namely, (Tilt 25% EC) @ 0.1% (T1), tebuconazole (Folicure 25.9% EC) @ 0.17% (T2), difenoconazole (Score 25% EC) @ 0.06% (T3), hexaconazole (Contaf plus 5% SC) @ 0.2% (T4), azoxystrobin (Amistar 23% SC) @ 0.1% (T5), carbendazim + mancozeb (Saaf 75% WP) @ 0.2% (T6) were tested against rust disease of garden pea. The crop was sown manually with spacing of 30 cm and 10 cm between rows and plants, respectively with seed rate of 75 kg ha-1 at depth of 4 cm. The agronomic practices were followed as per package of practices to raise a good crop. The crop was fertilized with basal dose of 20, 60 and 30 kg N, P and K ha-1 applied in furrows before sowing, respectively. Timely hoeing and weeding operations were carried out to ensure soil moisture and to remove weeds. The plots were irrigated with three times. The fungicides were sprayed twice at 15 days interval on the standing crop according to the treatments with the initiation of the disease symptoms, control plots were sprayed with plain water. The data were recorded from randomly selected 5 plants/plot for number of pods/plant, length of pod (cm) and seed yield (q/ha).

Per cent Disease Intensity (PDI): The per cent disease intensity was recorded on pea plant 1 day before spraying and 15, 30 days after spraying of fungicides. First spray of fungicides as per treatments, were taken up after initial appearance of disease in crop and further spray was given at 15 days interval. Five plants in each plot were tagged and per cent disease intensity was calculated by using following formula (Aduichy and Thakore, 2000).

$$\text{Disease intensity (\%)} = \frac{\text{Sum of all disease rating}}{\text{Total number of leaves x maximum grade}} \text{ x } 100$$

Results and Discussion

The data on per cent disease intensity of rust disease of field pea at one day before spray is furnished in table 1. The data on per cent disease intensity of rust disease of field pea at 15 days after spray is furnished in table 1. The data showed that all the treatments were significantly effective over control. Among all the treatments the minimum per cent disease intensity was recorded in T1- propiconazole (11.40%), followed by T3- difenoconazole (14.66%), further T2- tebuconazole (15.38%), respectively. The maximum per cent disease intensity was recorded in T0- (28.74%). The data on per cent disease intensity of rust disease of field pea at 30 days after spray is furnished in table 1. The data showed that all the treatments were significantly effective over control. Among all the treatments the minimum per cent disease intensity was recorded in T1- propiconazole (14.96%), followed by T3- difenoconazole (16.09%), further T2- tebuconazole (18.14%), respectively. The maximum per cent disease intensity was recorded in T0- Control (39.85%). Alam *et al.,* (2007) [2] also observed the similar findings in which they reported that all fungicides resulted significantly better performance over control. Considering per cent disease index (PDI), propiconazole performed better than other fungicides. The highest PDI of rust disease was observed in control treatment, where as the lowest PDI and per cent disease reduction over control was recorded in propiconazole may be used for controlling rust disease and increasing seed yield of field pea. Rahman *et al.,* (2005) [18] and Ahmad *et al.,* (2006) also reported that Tilt 25 EC (propiconazole) @ 0.1% was the most effective fungicide against rust disease. Singh and Tripathi (2004) [20] also find similar result.

Table 1: Per cent disease intensity of rust disease of field pea at different day's interval as affected by different treatments

Treatments	Concentration (%)	Per cent of disease intensity (PDI)		
		One day before spray	After spray	
			10 days	20 days
T0- Control	-	15.26	28.74	39.85
T1- Propiconazole	0.1%	7.54	11.40	14.96
T2- Tebuconazole	0.17%	8.47	15.38	18.14
T3- Difenoconazole	0.06%	10.11	14.66	16.09
T4- Hexaconazole	0.2%	11.25	15.85	21.55
T5- Azoxystrobin	0.2%	10.29	15.77	20.44
T6- Carbendazim + Mancozeb	0.2%	12.04	17.33	22.81
Overall mean	-	10.71	17.02	21.98
F- test	-	s	S	s
S. Ed. (+)	-	1.398	2.157	2.670
C.D. (P = 0.05)	-	2.963	4.572	5.660

The data on numbers of pods at one before spray is furnished in table 2. The data on numbers of pods at 15 day after spray is furnished in table 2. The data showed that all the treatments were significantly effective over control. Among all the treatment the maximum numbers of pods were recorded in T1- treatment with propiconazole (13.67), followed by T3- difenoconazole (13.33), further T2- tebuconazole (13.00), respectively. The minimum numbers of pods were recorded in T0 control (8.50). The data on numbers of pods at 30 days after spray is furnished in table 2. The data showed that all the treatments were significantly effective over control. Among all the treatments the maximum numbers of pods were recorded in T1- propiconazole (14.47), followed by T3- difenoconazole (14.27), further T2- tebuconazole (14.07), respectively. The minimum numbers of pods were recorded in T0- control (9.60). Alam *et al.,* (2007) [2] also find similar

results considering yield contributing characters (number of pods plant-1, length of pod and seed pod-1) propiconazole performed better than other fungicides.

Table 2: Numbers of pods/plant at different Days interval affected by different treatments

Treatments	Numbers of pods/plant		
	One day before spray	After spray	
		10 days	20 days
T0- Control	5.33	8.50	9.60
T1- Propiconazole	9.00	13.67	14.47
T2- Tebuconazole	8.13	13.00	14.07
T3- Difenoconazole	8.73	13.33	14.27
T4- Hexaconazole	8.00	12.33	13.60
T5- Azoxystrobin	8.33	12.67	13.87
T6- Carbendazim + Mancozeb	7.67	11.93	13.04
Overall mean	7.88	12.20	13.33
F- test	s	s	s
S. Ed. (+)	0.117	0.123	0.078
C.D. (P = 0.05)	0.249	0.262	0.166

The data on length of pod at one day before spray is furnished in table 3. The data on length of pod at 15 days after spray is furnished in table 3. The data showed that all the treatments were significantly effective over control. Among all the treatments the maximum length of pod was recorded in T_1- propiconazole (8.28 cm), followed by T_3- difenoconazole (8.11 cm), further T2- tebuconazole (7.99 cm), respectively. The minimum length of pod was recorded in T_0- control (6.61 cm). The data on length of pod at 30 days after spray is furnished in table 3. The data showed that all the treatments were significantly effective over control. Among all the treatments the maximum length of pod was recorded in T_2- propiconazole (9.68 cm), followed by T_3- difenoconazole (9.49 cm), further T2- tebuconazole (9.34 cm), respectively.. The minimum length of pod was recorded in T_0- control (7.72 cm). Alam *et al.,* (2007) [2] also find similar results considering yield contributing characters (number of pods plant-1, length of pod and seed pod-1) propiconazole performed better than other fungicides.

Table 3: Length of pod (cm) at different day's interval as affected by different treatments

Treatments	Length of pod (cm)		
	One day before spray	After spray	
		10 days	20 days
T0- Control	5.76	6.61	7.72
T1- Propiconazole	6.12	8.28	9.68
T2- Tebuconazole	5.95	7.58	9.20
T3- Difenoconazole	6.02	8.11	9.49
T4- Hexaconazole	6.01	7.99	9.34
T5- Azoxystrobin	5.93	7.43	8.98
T6- Carbendazim + Mancozeb	5.84	7.32	8.77
Overall mean	5.94	7.62	9.03
F- test	s	s	s
S. Ed. (+)	0.067	0.224	0.276
C.D. (P = 0.05)	0.142	0.474	0.585

The data on seed yield of field pea are furnished in table 4. The data showed that all the treatments were significantly effective over control. Among all the treatments the maximum seed yield was recorded in T_2- treatment with propiconazole (19.60 q/ha), followed by T3- difenoconaole (19.40 q/ha), further T2- tebuconazole (19.18 q/ha), respectively. The minimum yield was recorded in T0- control (13.75 q/ha). Results showed that the highest seed yield was recorded with spray of propiconazole. These results are in agreement with earlier workers Singh and Tripathi, (2004) [20]; Rahman *et al.,* (2005) [18] and Ahmed *et al.,* (2006) [1].

Table 4: Seed yield (q/ha) of field pea as affected by different treatments

Treatments	Seed yield (q/ha)
T0- Control	13.75
T1- Propiconazole	19.61
T2- Tebuconazole	19.18
T3- Difenoconazole	19.40
T4- Hexaconazole	18.95
T5- Azoxystrobin	18.98
T6- Carbendazim + Mancozeb	18.90
Overall mean	18.40
F-test	S
S. Ed. (+)	0.141
C.D. (P = 0.05)	0.300

Conclusion

From present study, it was concluded that spraying of Propiconazole @ 0.1%, 2 times at the interval of 15 days from the first appearance of disease symptoms was found as best treatment to control for rust disease of field pea. This also concluded that Propiconazole also increased the seed yield and yield attributing characteristics like number of pods/plant, length of pod, number of seeds/pod and seed yield. So, application of fungicides is an important tool for the management of rust disease.

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