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Uday Partap Singh
Asha Bhagwan Bax Singh P.G. Collage, Pura Bazar, Ayodhya, Uttar Pradesh, India

Dr. Chandra Shekhar
Associate Professor, Ag. Chemistry and Soil Science, Gochar Mahavidyalaya, Rampur Maniharan, Uttar Pradesh, India

Corresponding Author:
Uday Partap Singh
Asha Bhagwan Bax Singh P.G. collage, Pura Bazar, Ayodhya (UP), India

Evaluation of fungicides management of powdery mildew (*Erysiphe Polygoni* DC) disease of field pea (*Pisum Sativum* L.) in Eastern U.P.

Uday Partap Singh and Dr. Chandra Shekhar

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Abstract
The experiment was conducted to find out the efficacy of some new fungicides against powdery mildew (*Erysiphe polygoni* DC.) in the experimental field of experiment was laid out during rabi 2018-19 at supervision of Asha Bhagwan Bax Singh P.G. College Ayodhya, in the 7 farmer's field of Ayodhya and Ambedkarnager district of Uttar Pradesh. The experiment consisted of nine treatments viz. T1- Flusilazole 12.5% @ 1.0 ml/l., T2- Azoxystrobin 18.2 % w/w % @ 1.0 ml/l., T3- Tricyclazole 18 % @ 1.5 g/letter, T4- Propiconazole @ 1.0 ml/l., T5- Trifloxystrobin 25% @ 1.0 g/l, T6- Difenoconazole 11.4 % w/w SC @ 1.0 ml/l., T7- Mancozeb 50% @ 1.5 g/l., T8- Hexaconazole 4%WP @ 1.5 g/l.and T9- Untreated control (Spray of plain water), were applied the recommended dose of each product, were applied at the onset of disease. Minimum disease severity was recorded in propiconazole (8.58 % and 10.12 % at 10 and 20 days after spray respectively) followed by Azoxystrobin 18.2 % w/w (9.33 % and 11.17 % at 10 and 20 days after spray respectively) and significantly maximum disease intensity was observed in mancozeb (26.28 % and 29.13 % at 10 and 20 days after spray respectively) as compare to control (31.10 & 38.80%). The maximum pod yield of treated with propiconazole 11.13 t/ha increase over control 114.03% followed by Azoxystrobin 18.2 % w/w 10.18t/ha respectively.

Keywords: Field pea, treatments, fungal disease and fungicides

Introduction
Pea (*Pisum sativum* L.) is a valuable vegetable as well as pulse crop all over the world. It belongs to the family *Leguminoseae*, self pollinated crop (Anonymous 2005) [2]. The field pea is believed to be native to the Mediterranean region of southern Europe and Western Asia comprising Italy and south western Asia and India. In India, it is cultivated mainly in UP, MP, Bihar, Punjab, Haryana, Delhi etc (Singh and Singh 2005) [12]. Uttar Pradesh is the major field pea growing state. It is grown in India mainly for green pods and immature seeds, which are consumed as vegetables. The matured seeds are used as pulse, chatpati, etc. Green peas are rich in vitamin and proteins. Mature seed contain (g/100g weight food) 10.9g water 22.9g protein, 1.4g fat, 60.7g carbohydrate, 1.4g fibre and 2.7g ash (Duke and Ayensu, 1985) [4]. The pea has a great agronomic value. In crop rotation, it helps improvement of soil fertility and yield of succeeding crops (Rana and Sharma, 1993) [11]. The average yield of pea is quite low as compared to its yield potential. Major obstacles in the way of increased pea production are the diseases caused by the fungal, viral and bacterial pathogens. Pea is affected by several plant pathogens includes fungi, viruses and bacteria diseases. Eleven diseases of pea are reported (Bakr, 1994) [3]. They cause about 30-40% yield loss annually. Among the eleven diseases powdery mildew caused by *Erysiphe polygoni* De C. and rust caused by *Uromyces fabac de* Barry are two major diseases of pea. Yield reduction due to these diseases is very high within short period of time. Powdery mildew appears in epidemic form almost every year when the plants are in the pod stage towards the end of January and in February. Heavy reduction in pod formation in pea was occurred due to severe infection of powdery mildew in Bombay and reported that even one picking was not possible, whereas 67 pickings were obtained from a normal crop (Uppal *et al*., 1953) [15]. The losses in yield in a 100% infected crop were estimated by (Munjal *et al*. 1963) [7] to be 21-31% in pod number and 26-47% in pod weight. Rust of pea caused by *Uromyces fabae de Barry* is world wide distributed. It is a

macrocyclic autoecious rust. The symptoms of this rust appear first in the month of January. It attacks broad bean, pea, and until, causing partial defoliation of susceptible varieties. All the green parts of the plant including pods are affected. Among the fungal diseases powdery mildew incited by *Erysiphe polygoni DC* considered as one of the most devastating disease and cause severe damage throughout the worldwide in the countries viz. India, Bangladesh, Brazil, Phillippines, South Australia, Sri Lanka, Taiwan, Thailand, Tropical Africa, France, USA, Pakistan, China, Russia, Canada and many other countries. Thus by controlling these diseases through a suitable control measure such loss can be minimized. Many researchers tried to control this diseases chemically world wide (Suhag and Rana, 1984, Verma, 1986, Rahman *et al*. 1984, Bakr and Rahman, 1998, Rahman *et al*. 2005; Ahmed *et al*. 2006) [14, 9, 10, 1]. The disease is worst in dry weather with low humidity and low temperature. Yield reduction due to this disease is very high within short period of time. Sever infection may result in 24-27% reduction in pod weight, 21-30% reduction in pod number and up to 70% reduction in total yield (Prasad and Dwivedi 2007) [8].
Pea powdery mildew is traditionally suggested to be managed by many systemic and non-systemic fungicides which are found to have effect on controlling powdery mildew. Selection of proper fungicides and testing of their efficacy are essential aspects of this management strategy. Considering above point this study was undertaken to test efficacy of some new fungicides in controlling powdery mildew diseases of field pea.

Materials and Methods
The experiment were carried out at various parts of different villages in Ayodhya and Ambedkarnager of Uttar Pradesh viz. Marna and Jogapur (Ayodhya), Kewari, Parmanand (Ambedkarnager), were evaluated against powdery mildew disease of pea the most popular variety Rachna. Experiment was laid out in one village one replication. Most popular variety used was Rachna and the gross plot size was 50 sq. metres and all packages of practices were followed for conducting the experiment. This experiment was laid out in randomized block design with seven replications (four village of Ayodhya viz. Sarairasi, Marna, Jogapur & and three village of Ambedkarnager viz. Chachikpur, Barahi and Raniva). One village one replication, the soil of the farmers' field was sandy loam in texture, neutral in reaction and had low nitrogen and medium phosphorus and potassium contents. To evaluate the efficacy of new molecules/chemicals against powdery mildew, were tested. The experiment consisted of nine treatments viz. T1- Flusilazole 12.5% @ 1.0 ml/l., T2- Azoxystrobin 18.2 % w/w % @ 1.0 ml/l., T3- Tricyclazole 18 % @ 1.5 g/letter, T4- Propiconazole @ 1.0 ml/l., T5- Trifloxystrobin 25% @ 1.0 g/l, T6- Difenoconazole 11.4 % w/w SC @ 1.0 ml/l., T7- Mancozeb 50% @ 1.5 g/l., T8- Hexaconazole 4%WP @ 1.5 g/l.and T9- Untreated control (Spray of plain water), were applied the recommended dose of each product, were applied at the onset of disease. The insecticidal spray solution of desired concentration as per treatment was freshly prepared every time at the site of experimentation just before the start of spraying operations. The quantity of spray materials required for average of crop was gradually increased as the crop advanced in age. The spray solution of desired concentration was prepared by adoption of the following formula (Singh *et al*. 2009) [13].

N=T xP/a.i.

N= quantity of a formulated pesticide required.
T= total spray fluid required.
P= percentage strength required.
a. I= Given percentage strength of a formulated pesticide.

Observations on powdery mildew disease intensity were recorded on randomly selected plants from the each bottom, middle and top leaves (Wheeler 1969) [17]. The powdery mildew disease was graded on the basis of disease intensity observed on leaves by applying 0-9 disease rating scale developed by (Mayee and Datar 1986) [5] as described below.

Disease intensity (%) = Sum of all disease rating/Total number of leave X maximum grade X 100

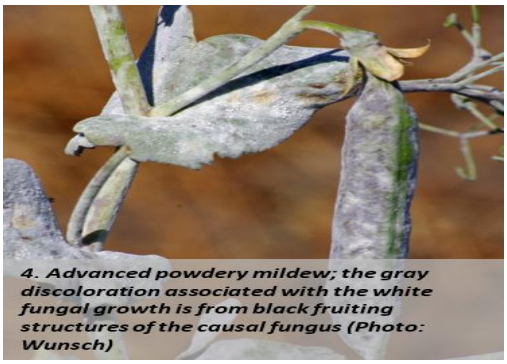
The data were recorded from randomly selected 10 plants/plot for plant height, pod/plant, length of pod, breadth of pod and seed/pod. Pod yield (ton/ha) and disease scoring data were recorded on whole plot basis and then disease score data converted into disease severity (PDI). The efficacy of fungicides was measured by scoring the disease severity (PDI) in the individual plot on the basis of a standard of scoring scale. Data were analyzed following the statistical procedure of Gomez and Gomez (1983) [6]. Treatment means were compared by DMRT (Duncan's Multiple New Range Tests).

Importance: Powdery mildew can be a very important disease when conditions are favorable. It reduces seed size and can sharply reduce yields if it develops during early to mid-pod development. Late planted peas are at greater risk for yield loss than early planted peas.

Symptoms: Powdery mildew causes white powdery fungal growth over all above-ground parts of the plant. The disease usually begins as small discrete white tufts. Once it appears, the disease can spread very fast and the white fungal growth can quickly cover entire leaves and other green tissues. As the disease is developing, the white fungal growth can be easily rubbed off, and the tissue underneath may appear normal or slightly yellowed. As the disease progresses, black specs (fungal reproductive structures) often develop within the white fungal growth, and the peas take on a bluish color.

Disease Cycle and Development. The pathogen overwinters in small black reproductive structures that release aerial spores in the spring/summer. Powdery mildew infection and development is favored when dry, warm weather are accompanied by nights that are cool enough for dew to develop. The disease can develop very rapidly when environmental conditions are favorable.

2. Powdery mildew – advanced disease (Photo: Markell)


4. Advanced powdery mildew; the gray discoloration associated with the white fungal growth is from black fruiting structures of the causal fungus (Photo: Wunsch)

Results and Discussion

There was significant difference among the treatments in Powdery mildew disease severity and yield. The data on disease intensity (%) of field pea powdery mildew at one day before spray is furnished in table 1. The data on disease intensity (%) of field pea powdery mildew at 10 days after spray.

Disease intensity (%) at ten days after spray: The plot treated with Propiconazole @ 1.0 ml/l was found best in checking the disease severity (8.58%) and incidence was (72.41%) respectively and the pod yield 11.13t/ha was recorded presented in Table-1& 2. While severity and incidence had gone to the extent of 31.10 and 72.41 % respectively in unsprayed plots. In check plots reduced grain yield was recorded (5.20 t/ha). In this treatment 114.03 increased pod yield over untreated check was observed. The plot treated with T2- Azoxystrobin 18.2 % w/w @ 1.0 ml/l the disease severity (9.33%) and 70.0% disease incidence, along with pod yield 10.18 t/ha was recorded. In treatment T5- Trifloxystrobin 25% @ 1.0 g/l, showed response of disease severity (18.20%) and 67.36 % disease incidence, along with pod yield 9.67 t/ha was recorded. In the plot treated with T8- Hexaconazole 4%WP @ 1.5 g/l. 15.10% disease severity and 51.44% disease incidence along with pod yield 9.33 t/ha.was recorded. The plot treated with T3- Tricyclazole 18 % @ 1.5 g/l. 17.10 % disease severity and 45.01% disease incidence with yield 8.81 t/ha was recorded. The plot treated with T6- Difenoconazole 11.4 % w/w SC @ 1.0ml /l. 18.20% disease severity and 41.47 disease incidence with yield 8.18 t/ha was recorded. The plot treated with T1- Flusilazole 12.5% @ 1.0 ml /l., 20.10% disease severity and 35.7%, disease incidence with yield 7.87 t/ha was recorded. The plot treated with T7- Mancozeb 50% @ 1.5 g /l., 26.28% disease severity and 15.49%, disease incidence with yield 7.32 t/ha was recorded.

Disease intensity (%) at twenty days after spray

The data showed that all the treatments are significantly superior over control. Among all the treatments the minimum disease severity and intensity (%) of powdery mildew was recorded in T4 -propiconazole (10.12 & 66.15) followed by T2 - Azoxystrobin 18.2 % w/w (11.17 & 71.21). The plot treated with T5- Trifloxystrobin 25%, 13.13% disease severity and 66.15%, disease incidence. The plot treated with T8- Hexaconazole 4%WP 25%, 18.12% disease severity and 53.29%, disease incidence. The plot treated with T3- Tricyclazole 18 %, 20.18%, disease severity and 25.18%, disease incidence. The plot treated with T6- Difenoconazole 11.4 % w/w SC, 21.13%, disease severity and 45.13%, disease incidence. The plot treated with T1- Flusilazole 12.5%, 23.60% disease severity and 39.17%, disease incidence and the plot treated with T7- Mancozeb 50% w/w the disease severity (29.13%,) and 24.92% disease incidence, significantly higher disease severity were recorded in control (38.80%).

All eight treatments significantly reduced the disease severity and incidence at all test locations when compared to control. Minimum disease severity was recorded in propiconazole. The maximum pod yield of treated with propiconazole 11.13 t/ha increase over control 114.03% followed by Azoxystrobin 18.2 % w/w 10.18t/ha respectively.

Table 1: Effect of fungicidal spray on disease intensity (%) of powdery mildew of field pea at different days of intervals

			Severity (Percent of disease index) (PDI)			Percent of disease control (PDC)	
	Treatments	Dose/l or g	Before spray	After spray		After spray	
				10 days	20 days	10 days	20 days
T1	Flusilazole 12.5%	1.0 ml	10.10	20.10	23.60	35.60	39.17
T2	Azoxystrobin 18.2 % w/w	1.0 ml	6.58	9.33	11.17	70.00	71.21
T3	Tricyclazole 18 %	1.5 g	9.25	17.10	20.18	45.01	47.99
T4	Propiconazole	1.0 ml	4.25	8.58	10.12	72.41	73.91
T5	Trifloxystrobin 25%	1.0 g	7.15	10.15	13.13	67.36	66.15
T6	Difenoconazole 11.4 % w/w SC	1.0 ml	9.70	18.20	21.13	41.47	45.54
T7	Mancozeb 50%	1.5 g	11.13	26.28	29.13	15.49	24.92
T8	Hexaconazole 4%WP	1.5 g	8.11	15.10	18.12	51.44	53.29
T9	Control (plane water spray)		15.26	31.10	38.80		
	S. Ed. (±)		1.40	2.21	2.71		
	C. D. (P = 0.05)		3.01	4.60	5.81		

Table 2: Effect of fungicidal spray on pod yield and yield parameters.

		Plant Height (cm)	No of pod/plant	Pod yield t/ha.	Pod yield increased over control (%)
	Treatments				
T1	Flusilazole 12.5%	74	13	7.87	51.34
T2	Azoxystrobin 18.2 % w/w	101	18	10.18	95.76
T3	Tricyclazole 18 %	81	15	8.81	69.42
T4	Propiconazole	110	19	11.13	114.03
T5	Trifloxystrobin 25%	95	16	9.67	85.96
T6	Difenoconazole 11.4 % w/w SC	77	14	8.18	57.30
T7	Mancozeb 50%	69	13	7.32	40.76
T8	Hexaconazole 4%WP	87	15	9.33	79.42
T9	Control (plane water spray)	56	10	5.20	

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