Efficacy Assessment of Various New Fungicides for Management of Powdery Mildew of Pea (Pisum sativum L. sub sp. hortense)

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Authors’ contributions

This work was carried out in collaboration among all authors. Author SA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BKS and AKS managed the analyses of the study. Authors AKM and UKD managed the literature searches. All authors read and approved the final manuscript.

ABSTRACT

The experiment was carried out to test the comparative efficacy of various new fungicides in management of powdery mildew disease of garden pea. The results obtained by the concerned study revealed that Tebuconazole 50% + Trifloxystrobin 25% WG at a dosage of 350 g/ha was highly effective in controlling powdery mildew disease after 1st, 2nd and 3rd spray as compared to other fungicides used followed by Tebuconazole 50% + Trifloxystrobin 25% WG @ 300 g/ha and Tebuconazole 250 EC (Tebuconazole 25.9 w/w EC) @ 700 ml/ha.

Keywords: Powdery mildew; pea (Pisum sativum) & fungicides etc.


1. INTRODUCTION

Pea “*Pisum sativum* L.” occupies a prominent place in legume vegetable crops grown in India. It occupies an area of 5.45 lakh ha with an annual production and productivity of 54.51 lakh tons and 10 tons/ha respectively [1]. 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 [2,3,4]. Therefore, the crop becomes vulnerable to a number of biotic stresses. This is accompanied by diseases like powdery mildew (*Erysiphe pisi*), Ascochyta blight (*Ascochyta* spp.), Bacterial blight (*Pseudomonas syringae* pv. *syringae*) and pea rust (*Uromyces pisi*). Out of these diseases, powdery mildew disease incited by *Erysiphe pisi* is a continuous threat in growing areas of Uttar Pradesh, which causes losses up to 70 per cent in severe form [5]. The disease can be managed by use of fungicides, early planting and by use of resistant cultivars. The disease has been reported to be managed by fungicide application [6]. Chemical control of the disease has been reported to be effective if applied at proper time and different chemicals have been tested for their efficacy against the disease from time to time [7,8,9].

The present investigation was therefore undertaken to test the efficacy of new fungicides for effective management of powdery mildew disease of garden pea.

2. MATERIALS AND METHODS

The experiment was conducted on Vegetable research farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the *Rabi* season of 2016-17 in Randomized Block Design (RBD) by using 8 treatments with three replications. The soil was sandy loam with good drainage and moderate water holding capacity. The plot size in the experiment was 3.6 × 3.2 m and the seeds were sown in rows 30 cm apart and at plant to plant distance of 8 cm. A basal dose of 30, 60, 50 kg N, P2O5 and K2O ha⁻¹ was applied respectively. The various treatments used in the study include Tebuconazole, Trifloxystrobin and Carbendazim. These fungicides were used in different combination at different doses. The various doses are depicted in Table 1. A mid maturing Garden pea cultivar (Azad Pea -3) was used for the present study. All the agronomical practices were followed as per the guidelines. In order to avoid the yield losses, the crop was protected by application of insecticides.

2.1 Percent Disease Incidence (PDI)

The field was investigated time to time to analyze the symptoms of powdery mildew disease. The observations were recorded for five randomly selected plants in each plot. First spray was done as soon as the disease was reported in the field. Second and third spraying was done 10 days after first spray and second spray respectively.

Disease disease incidence was calculated using the formula given below:

\[
\text{Disease incidence (\%) } = \frac{\text{Number of diseased leaves}}{\text{Total number of leaves inspected}} \times 100
\]

| Treatments | Dosage / ha | Active ingredient (a.i.) | Formulation (ml or g) |
|------------|------------|--------------------------|----------------------|
| T1 Control | --         | --                       | --                   |
| T2 Tebuconazole 50% + Trifloxystrobin 25% WG | 125 + 62.5 | 250                     |
| T3 Tebuconazole 50% + Trifloxystrobin 25% WG | 150 + 75  | 300                     |
| T4 Tebuconazole 50% + Trifloxystrobin 25% WG | 175 + 87.5| 350                     |
| T5 Trifloxystrobin 50% WG | 87.5 | 175                     |
| T6 Tebuconazole 250 EC (Tebuconazole 25.9 w/w EC) | 175 | 700                     |
| T7 Carbendazim 50% WP | 125 | 250                     |
| T8 Tebuconazole 50% + Trifloxystrobin 25% WG | 350 + 175 | 700                     |
2.2 Disease Severity Index (DSI)

Before spraying the fungicides, the disease severity was recorded for infected plants in each plot by referring 0-5 scale.

Disease severity was calculated using the formula given below [10]:

\[
\text{Disease Severity Index (\%) = \frac{\text{Sum of individual numerical rating}}{\text{Total no. of leaves assessed}} \times 100}
\]

**Table 2. Scale used for powdery mildew disease scoring**

| Percent infection in plant | Rating |
|---------------------------|--------|
| No powdery mildew symptoms | 0      |
| Traces to 10 % infection on leaves | 1 |
| 10.1-25 % infection on leaves | 2 |
| 25.1-50 % infection on leaves | 3 |
| 50.1-75 % infection on leaves | 4 |
| More than 75 % infection on leaves | 5 |

3. RESULTS AND DISCUSSION

The various fungicides employed worked very efficiently in controlling the powdery mildew disease and produced significant results. Tebuconazole 50% + Trifloxystrobin 25% WG at a dosage of 350 g/ha was highly effective in controlling powdery mildew disease after 1st, 2nd and 3rd spray as compared to other fungicides used followed by Tebuconazole 50% + Trifloxystrobin 25% WG @ 300 g/ha and Tebuconazole 250 EC (Tebuconazole 25.9 w/w EC) @ 700 ml/ha. The highest disease severity index was observed in untreated plot.

3.1 Percent Disease Incidence

The data pertaining to percent disease incidence of powdery mildew of green pea is shown in Table 3. The average value for disease incidence before the spray of fungicides ranged from 13.47 to 15.27 per cent. After five days of the first spray of fungicides, the maximum PDI was observed for T1 i.e. the controlled plot (22.63) followed by T6 (Tebuconazole 250 EC @ 700 ml/ha) and minimum PDI was observed for treatment T3 i.e. Tebuconazole 50% + Trifloxystrobin 25% WG @ 300 g/ha with a value of 17.17 followed by T4 i.e. Tebuconazole 50% + Trifloxystrobin 25% WG @ 350 g/ha (18.40). The maximum disease incidence after the 3rd spray was observed in untreated control plot i.e. T1 i.e. upt to 85.75. The minimum disease incidence after the 3rd spray period was observed for T4 i.e. Tebuconazole 50% + Trifloxystrobin 25% WG @ 350 g/ha (1.05) followed by T3 i.e. Tebuconazole 50% + Trifloxystrobin 25% WG @ 300 g/ha (1.67).

3.2 Disease Severity Index

3.2.1 Pre spray

The data pertaining to disease severity index of powdery mildew of green pea is shown in Table 4. Before spraying the fungicides, the maximum disease severity index was observed in Tebuconazole 50% + Trifloxystrobin 25% WG treated plots i.e. treatment T4 @ 350 g/ha (3.25) followed by treatment T2 @ 250 g/ha (3.04) and T3 @ 300 g/ha (2.96). Treatment T6 (Tebuconazole 250 EC @ 700 ml/ha) is comparable with treatment T5 (Tebuconazole 50% + Trifloxystrobin 25% WG @ 300 g/ha) in terms of disease severity of 2.94. The minimum disease severity index was recorded in treatment T5 Trifloxystrobin 50% WG @ 175 g/ha (2.37) followed by treatment T1 control plot (2.69) and treatment T8 Tebuconazole 50% + Trifloxystrobin 25% WG @ 700 g/ha (2.73).

3.2.2 Post spray

Five days after the first spraying the disease severity index was found higher. The minimum disease severity was reported in treatment T4 (6.24) which was treated with Tebuconazole 50% + Trifloxystrobin 25% WG @ 350 g/ha, followed by treatment T7 (6.40) which was treated with Carbandazim 50% WP @ 250 g/ha and treatment T3 i.e. Tebuconazole 50% + Trifloxystrobin 25% WG @ 300 g/ha (7.30). The treatment T1 i.e. the control plots were reported with maximum disease severity index (9.80) followed by treatment T8 i.e. Tebuconazole 50% + Trifloxystrobin 25% WG @ 700 g/ha (9.68) and treatment T5 Trifloxystrobin 25% WG @ 175 g/ha (9.39). The minimum disease severity index was recorded in treatment T6 which was treated with Tebuconazole 50% and Trifloxystrobin 25% WG of dose 350 g/ha which goes down from 7.30 to 0.21 after third spray followed by its dose 300 g/ha which significantly reduced from 8.61 to 1.33 after consecutive sprays and treatment T6 (9.74 to 1.62) which was treated with Tebuconazole 250 EC (700 ml/ha).
Table 3. Effect of fungicides on percent disease incidence of powdery mildew disease of garden pea

| T1    | Conc. (ml/g/ha) | Pre Spray | 1st spray 5 Days | 1st spray 9 Days | 2nd spray 5 Days | 2nd spray 9 Days | 3rd spray 5 Days | 3rd spray 9 Days |
|-------|-----------------|-----------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Control | -               | 13.47     | 22.63            | 42.63           | 58.27           | 56.48           | 73.29           | 85.75           |
| T2     | Tebuconazole 50% + Trifloxystrobin 25% WG | 250       | 15.21            | 19.98           | 25.52           | 19.01           | 11.81           | 9.26            | 2.98            |
| T3     | Tebuconazole 50% + Trifloxystrobin 25% WG | 300       | 14.82            | 17.17           | 23.85           | 14.87           | 10.52           | 6.68            | 1.67            |
| T4     | Tebuconazole 50% + Trifloxystrobin 25% WG | 350       | 16.27            | 18.40           | 23.53           | 15.80           | 10.38           | 6.15            | 1.05            |
| T5     | Trifloxystrobin 50% WG | 175       | 11.86            | 19.13           | 24.86           | 17.93           | 11.43           | 8.08            | 2.10            |
| T6     | Tebuconazole 250 EC (Tebuconazole 25.9 w/w EC) | 700       | 14.72            | 20.44           | 26.54           | 19.09           | 12.65           | 6.99            | 4.59            |
| T7     | Carbendazim 50% WP | 250       | 14.16            | 19.60           | 35.37           | 55.09           | 51.15           | 58.13           | 67.69           |
| T8     | Tebuconazole 50% + Trifloxystrobin 25% WG | 700       | 15.27            | 20.43           | 27.08           | 21.13           | 13.54           | 9.64            | 5.44            |

SE (d) | 2.53 | 2.69 | 2.04 | 2.73 | 1.39 | 4.02 | 1.65 |
CV%    | 21.41| 16.70| 8.70 | 12.09| 7.68 | 22.10| 9.45 |
SE.m.± | 1.79 | 1.90 | 1.44 | 1.93 | 0.99 | 2.84 | 1.17 |
CD(5%) | 5.43 | 5.77 | 4.37 | 5.85 | 2.99 | 8.62 | 3.54 |
CD(1%) | 7.53 | 8.01 | 6.06 | 8.12 | 4.15 | 11.96| 4.92 |
Table 4. Effect of fungicides on disease severity index of powdery mildew disease of garden pea

|                | Conc.(ml/g/ha) | Pre Spray | 1<sup>st</sup> spray | 2<sup>nd</sup> spray | 3<sup>rd</sup> spray |
|----------------|---------------|-----------|----------------------|---------------------|---------------------|
|                |               |           | 5 Days   | 9 Days   | 5 Days   | 9 Days   | 5 Days   | 9 Days   |
| T<sub>1</sub>  | Control       |           | 2.69     | 9.80     | 15.42    | 25.92    | 39.44    | 55.20    | 65.52    |
| T<sub>2</sub>  | Tebuconazole 50% +Trifloxystrobin 25% WG | 250       | 3.04     | 8.57     | 10.09    | 6.42     | 3.84     | 2.69     | 1.93     |
| T<sub>3</sub>  | Tebuconazole 50% +Trifloxystrobin 25% WG | 300       | 2.96     | 7.30     | 8.61     | 5.34     | 3.41     | 2.44     | 1.33     |
| T<sub>4</sub>  | Tebuconazole 50% +Trifloxystrobin 25% WG | 350       | 3.25     | 6.24     | 7.30     | 4.10     | 2.17     | 1.32     | 0.21     |
| T<sub>5</sub>  | Trifloxystrobin 50% WG                   | 175       | 2.37     | 9.39     | 10.55    | 7.74     | 5.44     | 3.28     | 2.42     |
| T<sub>6</sub>  | Tebuconazole 250 EC (Tebuconazole 25.9 w/w EC) | 700       | 2.94     | 8.37     | 9.74     | 6.35     | 3.79     | 2.55     | 1.62     |
| T<sub>7</sub>  | Carbendazim 50% WP                        | 250       | 2.83     | 6.40     | 12.34    | 18.68    | 24.18    | 33.35    | 39.17    |
| T<sub>8</sub>  | Tebuconazole 50% +Trifloxystrobin 25% WG | 700       | 2.73     | 9.68     | 14.56    | 20.65    | 26.72    | 35.14    | 41.46    |
| SE (d)         |               |           | 0.53     | 1.56     | 0.56     | 0.59     | 1.20     | 2.14     | 0.63     |
| CV%            |               |           | 22.71    | 23.92    | 6.43     | 6.78     | 12.52    | 18.22    | 4.82     |
| SE.m.±         |               |           | 0.38     | 1.11     | 0.39     | 0.42     | 0.85     | 1.52     | 0.45     |
| CD(5%)         |               |           | 1.16     | 3.41     | 1.21     | 1.28     | 2.62     | 4.67     | 1.38     |
| CD(1%)         |               |           | 1.63     | 4.78     | 1.70     | 1.80     | 3.67     | 6.55     | 1.93     |
The maximum disease severity index was observed in unsprayed plot T1, which was significantly higher than all the other treated plots (15.42 to 65.52). The fungicides Tebuconazole and Trifloxystrobin exhibited best results in reducing powdery mildew disease severity. This is due to the combined action of both the fungicides as Trifloxystrobin interferes with respiration of the pathogenic fungi and Tebuconazole interferes in process of building the structure of fungal cell wall. This chemical compound eliminates fungi by inhibiting their ability to spread spores, which slows growth. Finally it inhibits the reproduction and further growth of the fungus. The results are in accordance with the results obtained by Sharma et al. [11] in field pea.

Tebuconazole was also found effective in controlling powdery mildew disease. Huq and Nahar [12] had also found tebuconazole to be highly effective in controlling the diseases powdery mildew (Erysiphe pisi) and rust (Uromyces fabae) in pea. Singh and Singh [13] also reviewed that all the fungicide treatments significantly reduced the disease severity and increased the grain yield of pea. The results obtained are in conformity with the earlier reports of Begum [14]. Gupta and Shyam [15] analysed the efficacy of Triademefon, Hexaconazole, Difenoconazole, Flusilazole, Fenarimol, Penconazole, Mancozeb and Chlorothalonil, among these Hexaconazole (0.10%) and Difenoconazole (0.01%), were reported effective against powdery and increased yield. Hiremath and Lal [16] also evaluated the efficacy of various fungicides and concluded that propiconazole (11.4% and 14.96% at 10 and 20 days after spray respectively) showed minimum disease severity and similar results were obtained by Singh et al. [17].

4. CONCLUSION

From the experiment, we can conclude that Tebuconazole 50% + Trifloxystrobin 25% WG at a dosage of 350 g/ha was most effective in controlling the powdery mildew disease. This is due to the ability of Tebuconazole to inhibit the reproductive process of the pathogen thus hindering the growth and lowering down the metabolism and Trifloxystrobin acts on respiratory mechanism of the fungi and thus the combination of both the fungicides efficiently controlled the disease.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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