Int.J.Curr.Microbiol.App.Sci (2021) *10*(02): 2745-2753

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 02 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1002.303

Growth and Yield Attributes of Garden Pea (*Pisum sativum* L. sub sp. *hortense*) as influenced by Various Fungicides

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Keywords

Freezing, Canning purpose, Summer vegetable, Vitamins and minerals

Article Info

Accepted:
20 January 2021
Available Online:
10 February 2021

A B S T R A C T

With the objective of increasing the productivity of garden pea by minimizing the losses due to diseases, the growers are always looking forward for different ways to overcome it. In the current study, fungicides like Tebuconazole, Trifloxystrobin and Carbendazim are evaluated. The present investigation was carried out during the rabi season of 2016-2017 at the vegetable research farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to test the comparative efficacy of various new fungicides on growth and yield parameters of garden pea. The results revealed that Tebuconazole 50% + Trifloxystrobin 25% WG @ 350 g/ha has shown significant results in terms of both growth and yield.

Introduction

Garden pea belongs to family Leguminosae and is an extensively grown crop with diverse utlisation pattern and hence considered as an important crop (Boros and Wawer, 2009). It is grown throughout the tropical and temperate areas. It is widely cultivated as a winter vegetable in the plains of North India and as a summer vegetable in hills. It is highly nutritious in terms of proteins (7.2 g/100 g of edible portion), vitamins and minerals such as phosphorus (139 mg/100 g), magnesium (34 mg/100g) and iron (1.5mg/100g). It is fully explored as a kitchen garden crop and it is used for freezing and canning purpose commercially. Uttar Pradesh ranks first in area (2.19 lakh ha) and production with 24.96 lakh tons (Anonymous, 2017). It is one of the major commercial vegetable crops of Varanasi during rabi season. A significant yield reduction has been seen due to a major disease of garden pea, i.e. powdery mildew of garden pea caused by *Erysiphe pisi*. The pathogen

requires warm days and humid nights for its multiplication and the optimum temperature for conidial germination is 20°C (Fallon and Viljanen- Rallinson, 2001). The distinctive symptoms include distortion and stunting of leaves, shoots and flowers.

A severly infested crop manifests reduction in number of pods per plant up to 28.6% (Rathi and Tripathi, 1994). Not only this, the disease also leads to lower quality of crop including adverse effect on tenderometer values, flavour and appearance of peas for canning or freezing (Gritton and Ebert, 1975). Considering all the above stated points, present research was conducted to test the effect of various fungicides on growth and yield parameters of garden pea.

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. The field was laid out in complete randomized block design with eight treatments each replicated thrice. The details of the treatments employed for the experiment is shown in table 1. For the study, Garden pea cultivar (Azad Pea -3) was selected as the test variety.

The seeds were sown with a spacing of 30 cm between rows and 8 cm between the plants. A basal dose of 30, 60, 50 kg N, P_2O_5 and K_2O ha^{-1}, respectively was given. The recommended package of practices was followed except the fungicides. When the vines in pea begins the growth, bamboo canes were used to provide support. As soon as the disease symptoms were reported, fungicidal spray was done at an interval of 10 days with the help of knapsack sprayer. In the present study, total 12 characters including growth and yield attributes were studied. Growth and yield parameters included plant height (cm), number of pods per plant, pod length (cm), pod breadth (cm), average pod weight (g), number of grains per pod, shelling percentage, pod yield per plant (g), pod yield (kg/ha), seed index, seed yield per plant (g) and T.S.S. All the above characters were measured for five randomly selected plants from each plot and after that average values for each plot was calculated. All the measured data were subjected to statistical analysis and the final results were generated.

Results and Discussion

Remarkable results have been observed in growth and yield parameters by the different fungicides. Treatment T_4 i.e. Nativo (Tebuconazole 50 % and Trifloxystrobin 25 % WG) 350 g/ha has efficiently worked in increasing the yield of garden pea.

Plant height

Results on effect of different fungicidal treatments on plant height of garden pea was recorded and presented in Table 2. The data revealed that maximum plant height was observed in Tebuconazole 50% +Trifloxystrobin 25% WG @ 700 g/ha treated plots (78.20 cm) which was at par with Carbendazim 50% WP @ 250 g/ha (78.13 cm) which was significantly greater than other treatments. The minimum plant height was recorded in Tebuconazole 50% +Trifloxystrobin 25% WG @ 250 g/ha (69.33 cm) followed by T_1 i.e. absolute control plot (71.57 cm). The results obtained are in conformity with earlier reports of Sharma *et al.,* (2017) and Alam *et al.,* (2007).

Number of pods per plant

The data regarding the effect of fungicides on number of pods per plant was depicted in Table 2 and it showed that the number of fruits per plant was significantly affected by

the treatments, which ranged between 10.2 and 12.77. More number of pods was produced in Tebuconazole 50% +Trifloxystrobin 25% WG @ @ 350 g/ha (12.77) and was remarkably superior to all other treatments. It was followed by Tebuconazole 250 EC @ 700 ml/ha having 11.93 fruits per plant. Minimum number of pods were observed in absolute control plot i.e. T_1 (10.2). The results obtained are in accordance with earlier reports of Alam *et al.,* (2007) and Sharma *et al.,* (2017). The maximum number of pods per plant may have been obtained due to an increase in photosynthetic activity, less disease severity and also due to plant response to the chemicals sprayed. Ahmad *et al.,* (2007) and Teshome and Tegegn (2017) also reported maximum number of pods from the plots treated with fungicides.

Length and breadth of pods

Highest average value of length and breadth of pods was observed in Tebuconazole 50% +Trifloxystrobin 25% WG @ 350 g/ha with mean values of 8.97 cm and 1.59 cm respectively as shown in Table 2. Second highest length of pods were observed in Tebuconazole 50% +Trifloxystrobin 25% WG @ 250 g/ha (8.90 cm) and second highest width 1.55 cm was observed in Tebuconazole 250 EC @ 700 ml/ha and Tebuconazole 50% +Trifloxystrobin 25% WG @ 700 g/ha.

Shorter and thinner pods were observed in Tebuconazole 50% +Trifloxystrobin 25% WG @ 700 g/ha (8.44 cm) and absolute control plot (1.48cm) respectively. Alam *et al.,* (2007) also find similar results considering length and breadth of pod.

Average pod weight (g)

The data pertaining to the effect of fungicides on average pod weight was illustrated in Table 3. The observations exhibits that T_4 i.e. Tebuconazole 50% +Trifloxystrobin 25% WG @ 350 g/ha treated plots produced pods with maximum weight of mean value 10.03 g which was superior to all the other plots. It was followed by Tebuconazole 50% +Trifloxystrobin 25% WG @ 300 g/ha (9.77g), while untreated plot produced fruits with least weight (9.10 g) which was at par with Tebuconazole 50% +Trifloxystrobin 25% WG @ 700 g/ha (9.13 g) and Trifloxystrobin 50% WG @ 175 g/ha (9.15 g).

Number of grains per pod

The maximum grains per pod (8.07) was noted in Tebuconazole 50% +Trifloxystrobin 25% WG @ 350 g/ha treated plots followed by Tebuconazole 50% +Trifloxystrobin 25% WG @ 300 g/ha (7.87) and Tebuconazole 250 EC @ 700 ml/ha (7.43), whereas the minimum grains per pod (6.40) was recorded in controlled plot which was at par with Trifloxystrobin 50% WG @ 175 g/ha (6.53) and Carbendazim 50% WP @ 250 g/ha (6.60).

The pod normally contains 5 to 6 seeds but the number varies according to the cultivar and the growing conditions (Knott, 1987).

Shelling percent

The mean shelling percentage of all the treated plots were calculated and observations regarding the effect of fungicidal sprays is depicted in Table 3.

It is evident from the data that the Carbendazim 50% WP @ 250 g/ha recorded highest shelling percent of (41.83) which is at par with Tebuconazole 50% +Trifloxystrobin 25% WG @ 300 g/ha (41.76).

The controlled plot depicted minimum shelling percent (39.05) followed by Tebuconazole 50% +Trifloxystrobin 25% WG @ 350 g/ha (40.08) treated plots.

Pod yield per plant (g)

Data regarding effect of fungicidal treatments on pod yield per plant of garden pea was presented in tabular form (Table 3). Significant differences were observed with various fungicidal treatment for control of powdery mildew disease. The fungicides which were found efficient in controlling disease has shown to increase the yield of the plant. Tebuconazole 50% +Trifloxystrobin 25% WG @ 350 g/ha treated plots has given highest pod yield per plant (127.94 g) and was significantly superior to all the other treatments. Second highest pod yield was observed in Tebuconazole 50% + Trifloxystrobin 25% WG @ 300 g/ha treated plots (114.78 g). The control plot was found to be the lowest yielder with a pod yield per plant of (92.81g) followed by plots treated with a higher dose of Tebuconazole 50% +Trifloxystrobin 25% WG @ 700 g/ha (95.72 g).

Pod yield (kg per ha)

The data pertaining to response of fungicides on fruit yield is presented in the Table 4. The Tebuconazole 50% + Trifloxystrobin 25% WG @ 350 g/ha treated plots produced highest pod yield *i.e.* 13210.36 kg per ha which was at par with Tebuconazole 50% + Trifloxystrobin 25% WG @ 300 g/ha treated plots (12621.53 kg). The control plot was found to be the lowest yielder with a pod yield of 10642.36 kg per ha followed by Tebuconazole 50% + Trifloxystrobin 25% WG @ 700 g/ha treated plots with a total yield of 11264.47 kg per ha.

Seed Index (100 seed weight)

The 100 seed weight of all the treatments was recorded separately and the resulting observations are depicted in Table 4. Tebuconazole 50% + Trifloxystrobin 25% WG @ 350 g/ha treated plots recorded highest 100 seed weight (27.72 g) followed by Tebuconazole 50% + Trifloxystrobin 25% WG @ 250 g/ha treated plots (26.57 g). Whereas, the minimum seed weight was observed in control plot (25.19 g) followed by Carbendazim 50% WP @ 250 g/ha treated plots (25.33 g).

Seed weight is considered to be the most stable component of yield (Littleton *et al.*, 1979; Saxena, 1980; Saxena and Sheldrake, 1980; Saxena *et al.*, 1983). Variations in size and shape have been found in pea seeds ranging from 90 mg seed^{-1} to 400 mg seed^{-1} (Knott, 1987).

Table.1 Name of fungicides and their doses in different experimental plots.

Treatments		Dosage / ha	
		Active ingredient (a.i.) (g)	Formulation (ml or g)
T_1	Control	--	--
T_2	Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	125 + 62.5	250
T_3	Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	150 + 75	300
T_4	Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	175 + 87.5	350
T_5	Trifloxystrobin 50% WG	87.5	175
T_6	Tebuconazole 250 EC (Tebuconazole 25.9 w/w EC)	175	700
T_7	Carbendazim 50% WP	125	250
T_8	Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	350 + 175	700

Table.2 Effect of fungicides on plant height (cm) and number of pods per plant

Treatments	Plant height (cm)	Number of pods per plant	Pod length (cm)	Pod breadth (cm)
T_1 Control	71.57	10.20	8.51	1.48
T_2 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	69.33	11.60	8.90	1.52
T_3 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	74.83	11.73	8.79	1.52
T_4 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	74.47	12.77	8.97	1.59
T_5 Trifloxystrobin 50% WG	72.57	10.93	8.73	1.50
T_6 Tebuconazole 250 EC (Tebuconazole 25.9 w/w EC)	75.70	11.93	8.59	1.55
T_7 Carbendazim 50% WP	78.13	10.67	8.73	1.52
T_8 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	78.20	10.49	8.44	1.55
Grand Mean	74.35	11.29	8.70	1.52
SE (d)	1.50	0.68	0.15	0.03
CV %	2.47	7.42	2.11	2.22
SE.m.±	1.06	0.48	0.11	0.02
CD (5%)	3.21	1.47	0.32	0.06
CD (1%)	4.46	2.03	0.45	0.08

Table.3 Effect of fungicides on average pod weight and number of grains per pod

Treatments	Average pod weight (g)	Number of grain per pod	Shelling %	Pod Yield per plant (g)
T_1 Control	9.10	6.40	39.05	92.81
T_2 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	9.27	6.90	40.17	107.61
T_3 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	9.77	7.87	41.76	114.78
T_4 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	10.03	8.07	40.08	127.94
T_5 Trifloxystrobin 50% WG	9.15	6.53	40.60	100.10
T_6 Tebuconazole 250 EC (Tebuconazole 25.9 w/w EC)	9.23	7.43	41.20	110.00
T_7 Carbendazim 50% WP	9.17	6.60	41.83	97.89
T_8 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	9.13	6.87	40.24	95.72
Grand Mean	9.35	7.08	40.61	105.85
SE (d)	3.66	0.28	1.43	8.49
CV %	0.20	4.85	4.32	5.19
SE.m.±	0.60	0.20	1.01	15.75
CD (5%)	0.83	0.60	3.07	21.85
CD (1%)	0.28	0.83	4.26	7.34

Table.4 Effect of fungicides on pod yield (kg/ha) and seed index

Treatments	Pod Yield (Kg per ha)	Seed Index	Seed Yield per plant (g)	T.S.S.(◦ Brix)
T_1 Control	10642.36	25.19	73.42	15.13
T_2 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	11924.19	26.57	76.49	16.13
T_3 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	12621.53	26.27	80.75	15.47
T_4 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	13210.36	27.72	87.06	16.13
T_5 Trifloxystrobin 50% WG	11747.69	26.02	75.69	15.73
T_6 Tebuconazole 250 EC (Tebuconazole 25.9 w/w EC)	12197.63	25.92	79.22	15.80
T_7 Carbendazim 50% WP	11598.67	25.33	74.81	16.33
T_8 Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG)	11264.47	25.84	74.19	15.37
Grand Mean	11900.86	26.10	77.70	15.76
SE (d)	668.07	0.65	3.48	0.31
CV %	6.88	3.04	5.48	2.38
SE.m.±	472.40	0.46	2.46	0.22
CD (5%)	1432.87	1.39	7.46	0.66
CD (1%)	1988.74	1.93	10.35	0.91

Seed yield per plant (g)

The data on seed yield per plant is presented in Table 4. The data significantly differs among the treatments. Among the different fungicides used, Tebuconazole 50% + Trifloxystrobin 25% WG @ 350 g/ha treated plots produced seed yield of 87.06 g which is significantly superior to all other treatments.

The second highest seed yield was obtained in Tebuconazole 50% + Trifloxystrobin 25% WG @ 300 g/ha treated plots (80.75 g). The minimum seed yield was observed for absolute control plot (73.42 g) followed by Tebuconazole 50% + Trifloxystrobin 25% WG @ 700 g/ha (74.19 g). The yield components i.e. the number of pods plant^{-1} and plants unit area^{-1} were found to be strongly correlated to pea seed yield (French, 1990).

T.S.S. (◦ Brix)

The data on T.S.S. is illustrated in Table 4. The maximum T.S.S. was recorded in Carbendazim 50% WP @ 250 g/ha (16.33 ◦Brix) followed by treatment Tebuconazole 50% + Trifloxystrobin 25% WG @ 250 g/ha and Tebuconazole 50% + Trifloxystrobin 25% WG @ 350 g/ha with T.S.S. of 16.13 ◦Brix. The minimum T.S.S. is observed in untreated plot (15.13 ◦Brix) followed by Tebuconazole 50% + Trifloxystrobin 25% WG @ 700 g/ha (15.37 ◦Brix).

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How to cite this article:

Sonali Agrawal, B. K. Singh, Anand K. Singh, Deeptimayee Sahoo and Sarita. 2021. Growth and Yield Attributes of Garden Pea (*Pisum sativum* L. sub sp. *hortense*) as influenced by Various Fungicides. *Int.J.Curr.Microbiol.App.Sci.* 10(02): 2745-2753.
doi: https://doi.org/10.20546/ijcmas.2021.1002.303