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Efficacy of GI Chitosan in Management of Powdery Mildew of Pea

P. K. Kamble[1]*, S. R. Lohate[1], S. N. Hasabnis[1], S. G. Dalvi[2] and S. R. Chaudhari[3]

[1]*Department of Plant Pathology and Agricultural Microbiology, College of Agriculture, Pune, (M.S.) - 411005, India*
[2]*Department of Biotechnology and Tissue Culture, VSI, Pune-412307, India*
[3]*Department of Agricultural Botany, College of Agriculture, Pune, India*

**Corresponding author*

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A B S T R A C T

Pea powdery mildew is an air-borne disease of worldwide distribution. It is particularly damaging in late sowings or in late maturing varieties. It is caused by *Erysiphe pisi.* In order to bring residue free peas, there is need to manage these diseases through eco-friendly measures such as by using the chitosan which is antifungal as well as induces resistance in plants. GI chitosan is a deacetylated derivative of chitin obtained by gamma irradiation of chitosan. GI chitosan at concentrations @50 and 75 ppm was evaluated in the control of *Erysiphe pisi*. Leaves were sprayed with GI chitosan twice at 30 and 40 DAS.The best treatment was sprayings of GI chitosan @ 75 ppm at 30 and 40 DAS which recorded 11.88 and 7.18 per cent disease intensity and 52.34 and 79.06 per cent disease control, respectively and it was at par with recommended wettable sulphur fungicide treatment. The results indicated that there was highest yield in the treatments of GI chitosan @75 ppm at 30 and 40 DAS was30.49q ha^{-1} as compared to control i.e.13.84 q ha^{-1}. Depending on the concentration used, GI chitosan reduced development of powdery mildew from 52.34% to 79.06% and its effectiveness was similar to wettable sulphur at concentration 0.2% (standard). Efficacy of chitosan increased with increasing of its concentration. Thus, preventive sprays of GI chitosan reduce the powdery mildew intensity in pea.

Introduction

Pea (*Pisum sativum* L.) a valuable vegetable as well as pulse crop all over the world, is also known as ‘Matar’. Pea represents a wide range of agricultural and horticultural uses. Production and productivity of pea has been very low because of various reasons *viz*. poor germination, inadequate use of fertilizers, incidence of diseases and pests, etc. The crop is vulnerable to a number of diseases.

Powdery mildew posses a continuous threat to its successful cultivation in crop growing areas of the Maharashtra state. This disease usually appears late in the season, reaching maximum intensity during the pod formation stage. The primary sign of powdery mildew is greyish white, powdery blotches on leaves. Usually, powdery fungal growth appears first on the upper leaf surface. In a crop badly affected by powdery mildew, the reduction in number of pod per plant is estimated to be 28.6% (Rathi and Tripathi, 1994).

For managing these diseases farmers are spraying fungicides, which are toxic to human health. Since the green peas are directly consumed, it leads to many health problems.

In order to bring residue free peas there is need to manage these diseases through eco-friendly measures by using the chitosan which is antifungal as well as induces resistance in plants. This has no residual effect on any beneficial organism.

Chitosan is an organic natural biopolymer modified from chitin, which is the main structural component of squid pens, cell walls of some fungi and shrimp and crab shells (Suchada *et al.*, 2010).

Chitin is the second most abundant polymer in nature after cellulose (Cohen-Kupiec and Chet, 1998). Chitosan is comprised of 2-acetamido-2-deoxy-b-D-glucose (N-acetyl-D-glucosamine) and 2-amino-2-deoxy-b-D-glucan (D-glucosamine) attached via b-(1, 4) linkages (Austin *et al.*, 1981; Tsigos *et al.*, 2000) to form a high molecular weight (MW) biopolymer that is non-toxic and biodegradable.

The amine group derived positive charges on chitosan at pH of greater than 6.0 is largely responsible for conferring the diverse and unique physiological and biological properties of chitosan (Fukuda, 1980). It has been shown to modulate plant disease (Rodriguez *et al.*, 2007; Falcon-Rodriguez *et al.*, 2011), phytoalexin production and reactive oxygen species (ROS) generation (Lee *et al.*, 1999), induce cell wall lignification (Pospieszny and Zielinska, 1997; Vander *et al.*, 1998). Low molecular weight chitosan obtained by irradiation treatment, viz. microwave, UV, gamma rays etc. tissues and which induces a hypersensitive reaction as a consequence of oxidative microburst and phenolic compound.

Materials and Methods

Chitosan

The Gamma irradiated chitosan was kindly provided by Vasantdada Sugar Institute, Manjari, Pune which was prepared by irradiating normal chitosan with electron Beam 100 KGy dose at BRIT, BARC, Mumbai.

In vivo assessment of different GI chitosan concentrations and sulphur on disease development

The experiment was conducted in the experimental field of Vegetable Improvement Project, NARP, Ganeshkhind, Pune-67. Efforts were made to assess the physiological and biochemical changes due to GI chitosan concentrations spray on pea variety Arkel. Plants were observed twice at five days after each spray and record the disease severity using 0-9 scale (Mayee and Datar, 1986)

0 to 9 grade disease scale

Per cent disease intensity (PDI) was calculated on the basis of method suggested by Mc Kinney (1923).

Per cent disease intensity (PDI) =

$$\frac{\text{Sum of numerical rating}}{\text{Total number of leaves observed} \times \text{Maximum grade (i.e. 9)}} \times 100$$

Per cent disease control (PDC) was worked out by using the following formula

Per cent disease control (PDC) =

$$\frac{\text{PDI in control treatment} - \text{PDI in treatment}}{\text{PDI in control treatment}}$$

Statistical analysis

The complete data under the research experiments were statistically analyzed as per the procedure laid by Panse and Sukhatme (1969).

Results and Discussion

Bio efficacy of GI chitosan against powdery mildew of pea under field condition

The treatments were superimposed at 30 and 40 DAS and observations were recorded 5 days after spraying i.e. 35 and 45 DAS. GI chitosan reduced disease intensity of powdery mildew to a great extent at all concentrations.

Maximum reduction of powdery mildew was observed with wettable sulphur @ 0.2% at 30 and 40 DAS where 11.69 and 6.57 per cent disease intensity was recorded at 35 and 45 DAS respectively as against 24.93 and 34.27 percent disease intensity in control treatment. The next best treatment was sprayings of GI chitosan @ 75 ppm at 30 and 40 DAS which recorded 11.88 and 7.18 per cent disease intensity and 52.34 and 79.06 per cent disease control and it was at par with wettable sulphur fungicide treatment. Foliar sprays of GI chitosan @50 and 75 ppm were comparatively more effective than seed treatments of GI chitosan @50 and 75 ppm for 1 h. It was also observed that seed treatments with GI chitosan 50 and 75 ppm is resulted into significantly lower per cent disease intensity at 35 and 45 DAS in comparison to control.

The single and double sprays of GI chitosan were compared for there efficacy against powdery mildew of pea. It was observed in table 1, when GI chitosan sprayed @ 50 ppm at 30 DAS resulted into terminal per cent disease intensity 14.60 and GI chitosan sprayed @ 50 ppm at 40 DAS resulted into terminal per cent disease intensity 18.12.

Similarly, when GI chitosan sprayed @ 50 ppm twice at 30 and 40 DAS resulted into per cent disease intensity were 13.00 and 7.61 respectively. When GI chitosan sprayed @ 75 ppm at 30 DAS resulted into terminal per cent disease intensity 13.15 and GI chitosan sprayed @ 75 ppm at 40 DAS resulted into terminal per cent disease intensity 16.95. Similarly, when GI chitosan sprayed @ 75 ppm twice at 30 and 40 DAS resulted into per cent disease intensity were 11.88 and 7.18 respectively. Hence, the double foliar sprays of GI chitosan @ 50 and 75 ppm at 30 and 40 DAS were comparatively more effective than single sprays of GI chitosan @ 50 and 75 ppm at 30 and 40 DAS.

Table.1

Grade	Symptoms
0	No symptoms on the leaf
1	Minute powdery mildews lesions scattered covering 1% or less of the leaf area
3	Typical powdery mildew lesions covering 1-10% of the leaf area
5	Typical powdery mildew lesions covering 11-25% of the leaf area
7	Powdery mildew lesions covering 26-50% of the leaf area
9	Powdery mildew lesions covering 51% or more of the leaf area

Table.2 Intensity of powdery mildew in pea as influenced by different GI chitosan concentrations under field condition

Tr. no.	Treatments	Mean PDI 35 DAS	Disease reduction (%) 35 DAS	Mean PDI 45 DAS	Disease reduction (%) 45 DAS	Mean Yield (q ha^{-1})	Yield % Increase over control
1	Foliar spray of GI chitosan @ 50 ppm at 30 DAS	13.08 **21.20**	47.51	14.60 **22.45**	57.39	23.41	69.15
2	Foliar spray of GI chitosan @ 75 ppm at 30 DAS	11.79 **20.06**	52.71	13.15 **21.47**	61.64	25.87	86.92
3	Foliar spray of GI chitosan @ 50 ppm at 40 DAS	24.87 **29.89**	0.25	18.12 **25.16**	47.13	20.95	51.37
4	Foliar spray of GI chitosan @ 75 ppm at 40 DAS	24.63 **29.73**	1.19	16.95 **24.27**	50.55	23.22	67.72
5	Foliar sprays of GI chitosan @ 50 ppm at 30 and 40 DAS	13.00 **21.11**	47.84	7.61 **16.00**	77.81	28.89	108.74
6	Foliar sprays of GI chitosan @ 75 ppm at 30 and 40 DAS	11.88 **20.15**	52.34	7.18 **15.53**	79.06	30.49	120.30
7	Seed treatment GI chitosan @ 50 ppm for 1 h	20.23 **26.72**	18.85	27.24 **31.45**	20.52	19.90	43.79
8	Seed treatment GI chitosan @ 75 ppm for 1 h	19.18 **25.95**	23.05	25.50 **30.31**	25.61	20.98	51.59
9	Foliar sprays of wettable sulphur @ 0.2% at 30 and 40 DAS	11.69 **19.98**	53.12	6.57 **14.84**	80.83	31.23	125.65
10	Control	24.93 **29.93**	0.00	34.27 **35.81**	0.00	13.84	0.00
	SE (m) ±	0.55		0.78		0.30	
	CD (5%)	1.64		2.34		0.90	

Fig.1 Intensity of powdery mildew in peas influenced by GI chitosan at 35 and 45 DAS

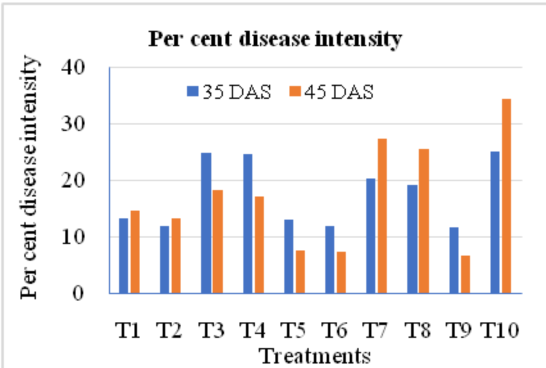
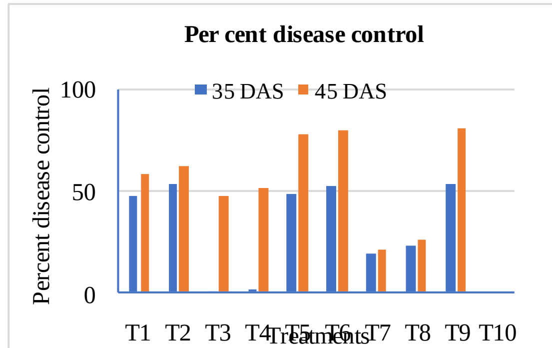


Fig.2 Per cent disease control of powdery mildew in pea as influenced by GI chitosan at 35 and 45 DAS



Faoro *et al.*,(2008) showed that the use of chitosan applied as a foliar spray on barley reduced locally and systemically the infection by powdery mildew pathogen *Blumeria graminis* f. sp. *hordei*.

The fungicide sprays with wettable sulphur @ 0.2 % at 30 and 40 DAS recorded statistically significant with higher yield (31.23 q ha^{-1}) and it was at par with foliar spray of GI chitosan @ 75 ppm at 30 DAS and 40 DAS (30.49 q ha^{-1}) and recorded 120.30 per cent increased over control. Seed treatment of GI chitosan @ 75 ppm for 1 h produced 20.98 q ha^{-1} of green pods and was 51.59 per cent increased over control. As the disease severity was increased, the yield of pea was decreased. It was observed that under absolute control yield was lowest (13.84 q ha^{-1}) (Table 2).

The results are in conformity with Abdel *et al.*, (2010) where they reported that chitosan solution was sprayed three times at ten weeks after transplanting with four weeks interval. They reported that chitosan application improved plant height, number of leaves, fresh and dry weight of the leaves and yield components (number and weight). Hien (2004) found that chitosan treatment also increased the productivity of soybean (using Mitani and Rajabasa varieties) in about 40 % than control. These results are in conformity with the present findings.

Thus, use of GI chitosan is found ecofriendly natural compound for management of powdery mildew of pea. The GI chitosan concentrations and number of sprays were increased from 50 ppm to 75 ppm and single spray to double sprays, the yield of pea was also increased from 23.41q $ha^{-1}$to 30.49q ha^{-1}. Hence, GI chitosan concentration and number of sprays were responsible for change in yield by lowering the disease severity.

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