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Evaluation of fungicides for the management of chrysanthemum white rust caused by *Puccinia horiana* Henn.

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ABSTRACT: Chrysanthemum white rust is a quarantine pest in many countries. In India, this invasive disease was first reported in Udagamandalam in Tamil Nadu in 2012 and has spread to chrysanthemum growing areas in Tamil Nadu and Karnataka. The disease turns epidemic when the night temperature is lower than 19-20°C. Since the disease is newly emerging in India, an attempt was made to evaluate fungicides for the management of this disease. Field evaluation for two years during 2015-16 and 2016-17 was carried out. Spraying chlorothalonil at 0.2% immediately after the first appearance of the rust pustules and continuing at fortnightly interval during Dec – Jan reduced the infection and prevented further spread. In 2015-16, the PDI in chlorothalonil treated plots did not rise above 10 PDI while in control it reached 78.8 PDI. In 2016-17 also, chlorothalonil was found effective with less than 10 PDI while in control it reached above 70 DPI. The next best chemical was propiconazole with 20 PDI. Myclobutanil which was found effective in Europe was not found effective in our study.

Keywords: Chrysanthemum, cholorothalonil, fungicide, management, *Puccinia horiana*, rust

INTRODUCTION

Chrysanthemum (*Chrysanthemum morifolium*) is one of the important ornamental crops giving livelihood for many marginal and small farmers besides being grown in large scale by progressive farmers. It is grown for both garland making and in landscape gardening. Major chrysanthemum growing states in India are Karnataka, West Bengal, Maharashtra, Tamil Nadu, Punjab, Rajasthan, Gujarat and Himachal Pradesh. Though many plant pathogens attack chrysanthemum, white rust caused by *Puccinia horiana* belonging to uridinales of basidiomycetes fungi is becoming serious threat in recent times. The white rust is a misnomer in case of chrysanthemum. It is not typical white rust caused by *Albugo* species belonging to oomycetes. Because of yellowish white pustules, the name white rust is used for this disease. This disease is a quarantine pest in many countries. The disease was first reported in Japan (Hennings 1901) and later in England (Baker 1967). It is native to East Asia but now it is widespread in Australia, Africa, Europe and South and Central America. It was first observed in India in 2012 from Udagamandalam (Tamil Nadu) and Bangalore (Karnataka) (Sriram *et al*. 2015). In European countries, myclobutanil (Bonde *et al*. 1995) has been found effective. Triazoles or strobilurins have been used in many countries (Cook 2001; Matsuura 2019). However, there is a need to evaluate the efficacy of fungicides for the management of this disease in India. No chemical has label claim for this disease in India. Hence, the present work was taken up to evaluate the efficacy of fungicides for the management of chrysanthemum rust.

MATERIALS AND METHODS

Treatments and season

Based on *in vitro* assays conducted earlier, formulations or technical grades of fungicides viz., bitertenol (0.1%), carboxin (0.1%), propiconazole (0.1%), myclobutanil (0.1%), hexaconazole (0.1%) and chlorothalanil (0.2%) were selected for testing their efficacy under field conditions for the management of chrysanthemum white rust. Field experiment was carried out in rabi season during 2015-16 and 2016-17. Since the severity of disease is high during the period when night temperature goes below 19°C, rabi season was chosen.

Field trial

Locally cultivated chrysanthemum variety named as "Marigold type" was chosen as it is highly susceptible to the chrysanthemum rust. Rooted cuttings of disease free planting material were planted during the first week of October in both years. The experiment was conducted in the experimental farm of Indian Institute of Horticultural Research, Hessaraghatta lake post, Bengaluru. The

cultural operations and input provision were as per the standard recommendation of package of practices except for application of fungicides. No fungicide was sprayed other than the treatments mentioned earlier. Immediately after the appearance of first few pustules the first spray was given and continued at 15 day interval. During 2015-16, the disease incidence continued till February end while in 2016-17 the progress of the disease slowed down after January end.

Disease scoring and data collection

Disease scoring of 0-4 scale developed by Bonde *et al.* (1995) was followed where in 0 = no infection, 1 = fewer than 5 pustules, 2 = 5-100 pustules per plant, 3 = more than 100 pustules per plant 4 = more than 100 pustules per plant and two or more leaves with coalesced lesions covering at least 75% leaf area. Observations were recorded five days after each spraying at weekly interval. The results were analysed by ANOVA at p=0.05. The area under disease progress curve (AUDPC) for all the treatments in both years were also calculated. Per cent Disease Index was calculated using the formula,

$$PDI = \frac{\text{Sum of numerical values of disease score} \times 100}{\text{Number of leaves graded} \times \text{Maximum rating}}$$

AUDPC was determined using the following formula (Cambell and Madden 1990).

$$Ak = \sum_{i=1}^{Ni-1} \frac{(yi + yi+1)}{2} (ti+1 - ti)$$

where y_i is the proportion of disease on the i^{th} observation, t_i is the time (days) of observation expressed as days after spraying and n is the total number of disease severity readings (PDI) taken throughout the experimental period. Besides the data on disease incidence, the flower yield also was recorded.

RESULTS AND DISCUSSION

'Marigold' variety of chrysanthemum is highly susceptible to rust caused by *Puccinia horiana*. Evaluation of fungicides for the management of chrysanthemum rust was taken up under field conditions for two years 2015-16 and 2016-17.

Disease incidence

I year

During 2015-16, the first pustule formulation was observed on 24th December and first spray was given on the same day and continued at 15 day interval. The disease incidence was recorded from 30th December at weekly interval. The evaluation of fungicides under field condition showed that use of chlorothalonil at 0.2% from first pustule formation at 15 days interval kept the disease severity under control (less than 10 PDI) while in untreated plots the severity increased to 78.8 PDI on 20th Jan 2016 (Fig.1). In plots treated with carboxin, hexaconazole and myclobutanil the disease severity did not come below 30 PDI in spite of three sprays. However, in chlorothalonil treated plots the disease never increased beyond 10 PDI.

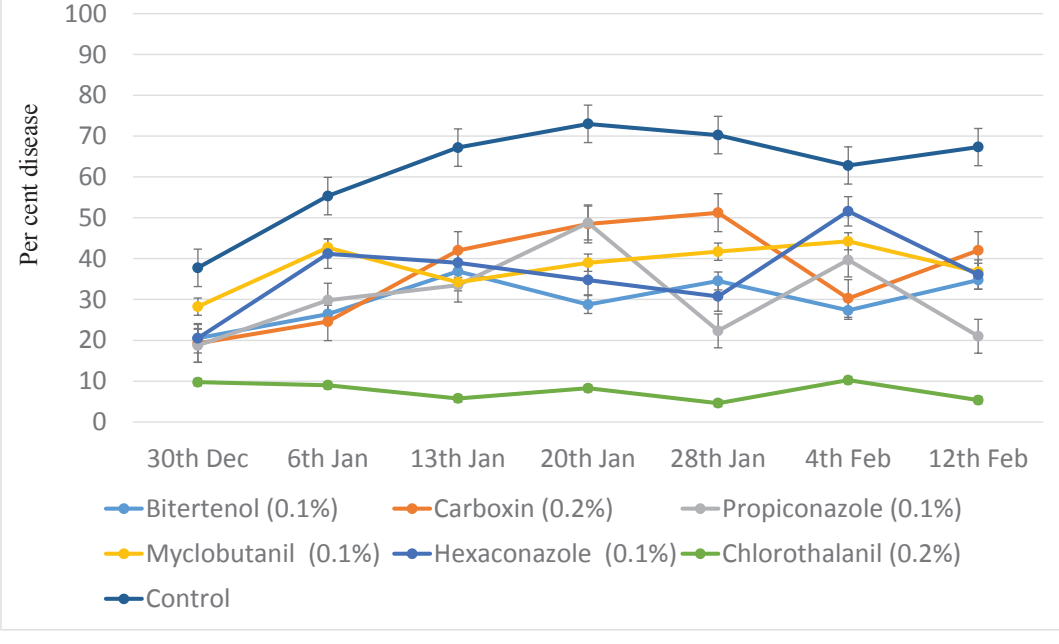

Fig 1. Evaluation of fungicides for the management of chrysantheum rust 2015-16

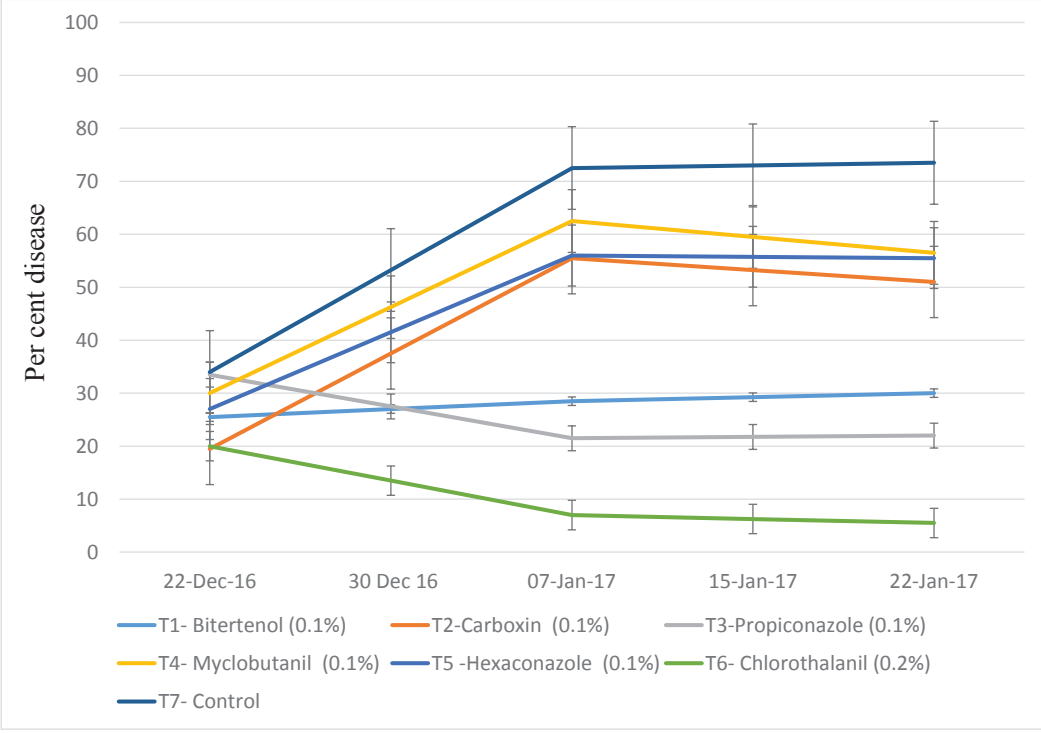

Fig 2. Evaluation of fungicides for the management of chrysantheum rust 2016-17

II year

During 2016-17, the appearance of first pustule was noticed on 16th December 2016 and spraying was started on the same day and continued at 15 day interval. The observations were recorded from 22nd December and continued at weekly interval. Second year trial also showed that use of chlorothalonil at 0.2% from first pustule formation (16th Dec 2016) kept the disease severity under control. (Fig.2) From 20 PDI it reached less than 10 PDI while in untreated plots the severity increased to PDI above 70. The second best treatment was propiconazole at 0.1% where the PDI was reduced to 20% after second spray. Chemicals myclobutanil, carboxin and hexaconazole were not so effective in controlling this disease because the disease severity was between 50 – 60 PDI even after 2-3 sprays in plots treated with these chemicals.

AUDPC

The AUDPC was high (381.1) in control plot in 2015-16 while it was lowest in Chlorothalonil treated plot (45.4). Though bitertenol and propiconazole gave better control (50% reduction) the AUDPC ranged from 180-195 as longer time was required to reduce the incidence. Myclobutanil and hexaconazole did not reduce the disease incidence and they had AUDPC of 225-235. In 2016-17 the AUDPC was lower than previous year in general as the disease did not prevail after last week of January. In second year also, AUDPC was lower (19.8) in chlorothalonil treated plot compared to 126 in control plot and myclobutanil, carboxin and hexaconazole were not effective (Table 1).

Yield

There was negative relation between AUDPC and yield. In the first year, in control plot the yield was 1.54 kg (in 10 plants, 10 harvests) while in chlorothalonil and propiconazole treated plots the flower yield was 2.46 kg and 2.39 kg respectively. In second year also, the yield was higher in chlorothalonil, propiconazole and hexaconazole treated plots with 2.96 kg, 2.86 kg and 2.62 kg respectively while in control it was only 1.85 kg (Table 1).

DISCUSSION

In the last century, mostly oxycarboxin or carboxin were used for the rust disease management. But development of resistance to oxycarboxin in *P. horiana* has been reported by Abiko *et al*. (1977). Bonde *et al*. (1995) reported that myclobutanil was very effective curative agent for the chrysanthemum white rust. Palmer *et al*. (2015) screened different fungicides for their effect on the *in vitro* germination of basidiospores of *P. horiana* and generated base line sensitivity data for different

Table 1. Effect of fungicides on Area under Disease Progress Curve for chrysanthemum rust and flower yield

Treatment	AUDPC		Flower yield in kg$	
	2015-16	2016-17	2015-16	2016-17
T_1- Bitertenol (0/1%)	181.5b	56.3b	1.83b	2.20b
T_2 –Carboxin (0.1%)	227.2c	90.8c	1.76ab	2.11b
T_3- Propiconazole (0.1%)	194.0b	49.3b	2.39d	2.86cd
T_4 –Myclobutanil (0.1%)	234.4c	105.8cd	1.71ab	2.05b
T_5- Hexaconazole(0.1%)	225.6c	97.3c	2.18c	2.62c
T_6- Chlorothalanil (0.2%)	45.4a	19.8a	2.46d	2.96d
T_7 – Control	381.1d	126.3d	1.54a	1.85a
CD at P=0.05	19.2	21.1	0.20	0.18
CV (%)	14.5	18.1	11.3	13.5

$ cumulative of 10 harvests, 10 plants per plot, Values followed by same alphabet in a column do not differ significantly as per DMRT at P=0.05

chemicals. They found that effective concentration to inhibit 50% germination (EC50) for benzimidazole was ranging from 9-224 ppm, while strobilurins ranged from 2-27 ppb. Contact fungicide mancozeb needed 7 ppm and chlorothalonil needed 205 ppb to achieve EC50. In the present study also, the effect of chlorothalonil was confirmed in the field level. In other countries, the curative chemicals have been identified. Propiconazole and azoxystrobin have been found to be curative fungicides for the management of chrysanthemum rust (Dickens, 1991; O'Neill and Pye, 1997; Wojdyla and Orlikowski, 1999). In India, Dheepa *et al*. (2016) reported that *Bacillus subtilis* isolates could be used for the management of this disease though it was less effective than that of azoxystrobin. Rahardjo *et al*. (2019) used plant-derived products along with hexaconazole for the management of chrysanthemum white rust. The use of azoles and strobilurins have the problem of development of resistance in *P. horiana*as reported earlier by Cook (2001) and Matsuura (2019). Since the pathogen is an invasive pathogen it has not yet developed resistance to azoles and strobilurinsin India. The present results suggest that spray with chlorothalonil at 0.2% or propiconazole at 0.1% will reduce or prevent the infection. However, development of resistant varieties will definitely provide durable solution in managing this disease.

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REFERENCES

Abiko, K., Kishi, K., Yoshioka, A. 1977 Occurrence of oxycarboxin-tolerant isolates of *Pucciniah oriana* P. Hennings in Japan. *Annals of Phytopathological Society of Japan*, 43: 145–150.

Baker, J.J. 1967. Chrysanthemum white rust in England and Wales 1963-66. *Plant Pathology* **16:** 162-166.

Bonde, M.R., Peterson, G.L., Rizvi, S.A., Smilanick, J.L. 1995. Myclobutanil as a curative agent for chrysanthemum white rust. *Plant Disease*, **79:** 500-505

Cambell, C.L. and Madden, L.V. 1990. Introduction to plant epidemiology. Wiley, New York

Cook, R.T.A. 2001. First report in England of changes in the susceptibility of *Puccinia horiana*, the cause of chrysanthemum white rust, to triazole and strobilurin fungicides. *Plant Pathology,* **50***:* 792

Dheepa, R., Vinodkumar, S., Renukadevi, P. and Nakkeeran, S. 2016. Phenotypic and molecular characterization of chrysanthemum white rust

pathogen *Puccinia horiana* (Henn) and the effect of liquid based formulation of *Bacillus* spp. for the management of chrysanthemum white rust under protected cultivation. *Biological control*, **103:**172-186.

Dickens., J.S.W, 1991. Evaluation of some newer fungicides in comparison with propiconazole against chrysanthemum white rust (*Pucciniahoriana*). *Tests of Agrochemicals and Cultivars,* **12**: 32-33

Dirkse., F.B., Dil, M., Linders, R and Rietstra, I. 1982. Resistance in whiterust (*Puccinia horiana* P. Hennings) of chrysanthemum tooxycarboxin and benodanil in the Netherlands. *Mededelingen Faculteit Landbouwwetenschappen Rijksuni versiteit Gentics,* **47:** 793-800.

Hennings, P. 1901. *Einigeneuejapanische uredineen* [Some new Japanese rusts]. *Hedwigia* **40:** 25-26.

Matsuura, S., 2019. Does QoI (strobilurin) resistance in isolates of *Puccinia horiana*, the causal agent of chrysanthemum white rust, occur in western Japan? *Journal of Plant Diseases and Protection*, 1-5.DOI: 10.1007/s41348-019-00224-w

O'Neill, T.M. and Pye, D., 1997. Evaluation of fungicides for control of chrysanthemum white rust (*Puccinia horiana*). Tests of Agrochemicals and Cultivars **18:** 8-9

Palmer, C.L., Bonde, M.R., Nester, S.E., Revell, J.M. and Luster, D.G. 2015. Fungicide impact on in vitro germination of basidiospores of *Puccinia horiana*, the casual agent of chrysanthemum white rust. *Plant Health Progress*, **16** (2): 73-76.

Rahardjo, I.B., Budiarto, K. and Marwoto, B. 2019. Evaluation of biological and chemical fungicides to control white rust in chrysanthemum grown under open condition. *AGRIVITA, Journal of Agricultural Science*, **41** (1): 55-63

Sriram,S., Chandran, N. K., Kumar, R., & Reddy, M. K. 2015. First report of *Puccinia horiana* causing white rust of chrysanthemum in India. *New Disease Reports*, **32:** 8

Wojdyla, A.T. 2004. Development of *Puccinia horiana* on chrysanthemum leaves in relation to chemical compounds and time of their application. *Journal Plant Protection Research,* **44:** 91–102

Wojdyla, A.T. and Orlikowski, L.B. 1999. Strobilurin compounds in the control of rust, powdery mildew and black spot on some ornamental plants. *Mededelingen Faculteit Landbouwkun dige En Toegepaste Biologische Wetenschappen Universiteit Gent* **64**: 539-545.

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