Influence of antagonistic agent, plant products and chemical agents on the powdery mildew disease of bhendi and its production

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ABSTRACT

Field investigations were made to study the influence of integrated disease management involving plant products and biological control agents of powdery mildew of Bhendi (*Erysiphe cichoracearum* DC) with ten treatments *viz.*,*Pseudomonas fluorescens* I_{18} (0.2%), *P.fluorescens* 1(0.2%), *Ocimum sanctum* 10%, Neem Seed Kernel Extract 5%, K_2HPO_4 50 mM, Salicylic acid 1mM, *O. sanctum* 5% + *P. fluorescens* I_{18} (0.2%),Neem Seed Kernel Extract 5 % + *P.fluorescens* I_{18} (0.2%), Carbendazim 0.1% and Control. Two sprays were given; first one on 30 days after sowing and the second one on 60 days after sowing. Powdery mildew disease severity was recorded at weekly interval after the second spray on randomly selected plants based on 0-5 grade scale and PDI was calculated. At the end of the season, yield was recorded in each plot. The minimum disease incidence of 8.83% was recorded with Neem Seed Kernel Extract 5%+ *Pseudomonas fluorescens* I_{18} 0.2% followed by 9.49% with *Pseudomonas fluorescens* I_{18} 0.2%,10.36% with carbendazim and 11.9% with *Pseudomonas fluorescens* -1.The yield was also increased to the tune of 43.43% over control in NSKE 5%+*Pseudomonas fluorescens* I_{18} followed by 42.44% in *Pseudomonas fluorescens* I_{18},41.84% with 0.1% carbendazim and 39.73% with *Pseudomonas fluorescens* -1.

Keywords: *Erysiphe cichoracearum*, powdery mildew disease, biopesticides, chemical agents

INTRODUCTION

Bhendi, an important vegetable crop in India, is affected by powdery mildew disease caused by *Erysiphe cichoracearum* DC. Powdery mildew continues to pose a serious threat to Bhendi production by inflicting heavy losses. Since Bhendi is grown throughout the year, management of the disease is important to get profitable yield. At present for the management of diseases in vegetable crops chemical fungicides are the first choice for the farmers. With increasing awareness of possible deleterious effects of fungicides on the ecosystem and growing interest in pesticide free agricultural products biological control now appears to be a promising strategy for managing diseases in a range of crops (David, 2008). Colonization by an antagonist is a pre requisite for biological control and thus organisms that grow well on the phylloplane are usually better candidates. The tactics for improving phyllosphere biological control involves manipulations either of the plant or microbial agent (Aggarwal and Srivastava, 2001). Investigations were carried out to gather information for the effective management of powdery mildew of Bhendi by biopesticides like *Pseudomonas fluorescens* I_{18}, *P.fluorescens* 1, aqueous extract of *Ocimum sanctum* leaf, Neem Seed Kernel Extract (NSKE) and chemical agents such as K_2HPO_4, salicylic acid, carbendazim along with control (water).

MATERIALS AND METHODS

Experimentation and treatments

Field trail was laid out in Randomized Block Design with a plot size of 5 x 4 m each using the variety, Arka Anamika at Mamsapuram, Virudhunagar district, Tamil Nadu with the following ten treatments *viz.*, *Pseudomonas fluorescens* I_{18} (0.2%) (PFI18), *P.fluorescens* 1 (0.2%) (PF1), aqueous extract of *Ocimum sanctum* leaf (10%) (OSAE), neem seed kernel extract (5%) (NSKE) , K_2HPO_4 (50 mM), salicylic acid (1mM), *O. sanctum* 5% + *P. fluorescens* I_{18} (0.2%), neem seed kernel extract (5 %) + *P.fluorescens* I_{18} (0.2%), carbendazim (0.1%) and control (water). Two sprays were given; first one on 30 days after sowing and the second one on 60 days after sowing. Powdery mildew disease severity was recorded at weekly interval after the second spray on randomly selected plants based on 0-5 grade scale and PDI was calculated. At the end of the season, yield was recorded in each plot.

Quantification of phylloplane *P. fluorescens* after spraying

Bhendi leaf samples from *P.fluorescens* sprayed treatment and control plots were collected at 0, 1, 7, 14, 21, 28 days after spraying. On each sampling period one gram of leaf sample was weighed and cut into small bits by means of a sterilized scalpel. The leaf bits were suspended in 10 ml of sterile distilled water, thoroughly shaken for five minutes and allowed to stand for five minutes to give 10^{-1} dilution. From 10^{-1} dilution, 1ml aliquot was added to another 9 ml of sterile water blank to give 10^{-2} dilution. Likewise dilutions up to 10^{-6} were prepared. Fifteen ml of King's B medium was added to plates containing 1 ml of 10^{-6} dilution. The plates were gently rotated for mixing the inoculum with the medium. Three replications were maintained. Colonies were counted after two days of incubation and the results were expressed as CFU x 10^6 g of leaf.

Statistical analyses

The data of PMD incidence were transformed into arc sine for statistical scrutiny, wherever necessary (Gomez and Gomez, 1984). The data were subjected to statistical scrutiny following the method of Panse and Sukhatme (1989) and Gomez and Gomez (1984) and the means were compared with Least Significant Difference (L.S.D.).

RESULTS

Powdery mildew incidence

In the field trial conducted for the management of powdery mildew of bhendi using plant products, antagonists and abiotic elicitors, the per cent disease index was ranged from 6.22 (NSKE + *P. fluorescens* I_{18} at 1 WAS) to 78.44 (Control at 4 WAS) (Table 1). The influence of the treatments, periods of observations and their interaction effect were significant. Overall mean disease intensity for the treatments ranged from 10.16 to 57.66. The per cent disease reduction over control in the tested treatments ranged from 54.04 (*O. sanctum*) to 82.38 (NSKE + *P. fluorescens* I_{18}).

Phylloplane survival of *Pseudomonas fluorescens*

The data on the survival of *P. fluorescens* on leaves of bhendi after foliar spraying showed that there was an initial increase in the population even on the very next day of spraying in all the treatments (except control) and the increasing trend continued upto 14 days after spraying (Table 2).The population of *P. fluorescens* on leaves of bhendi after foliar spraying with the treatments varied from 3.50 to 46.00 x 10^6 cfu g^{-1} of (Table 2). The treatments, periods of observation and their interaction effect exhibited significant influence on the population of *P. fluorescens*. Overall mean values indicated that application of *P. fluorescens* I_{18} recorded the highest population of *P. fluorescens* followed by NSKE + *P. fluorescens* I_{18}, *P. fluorescens* 1 , *O. sanctum* + *P. fluorescens* I_{18} and control. The population of *Pseudomonas* attained a peak at fourteenth day after treatment (34.85) and thereafter the population declined. Though the *Pseudomonas* population decreased after 14 days, the level at the final sampling period was more than

Table 1. Effect of biotic and abiotic treatments in the management of powdery mildew disease of bhendi

Treatments	WAS				Mean	Disease reduction (%)
	1	2	3	4		
P. fluorescens I_{18}	6.44(14.65)^{ab}	10.33(18.72)^{b}	12.22(20.44)^{a}	16.22(23.73)^{bc}	11.30(19.37)^{b}	80.40
P .fluorescens 1	7.11(15.45)^{cd}	11.99(20.18)^{c}	15.55(23.18)^{b}	18.66(25.55)^{c}	13.33(21.10)^{c}	76.88
O. sanctum	9.11(17.56)^{d}	22.44^{g}(28.25)	34.22^{ef}(35.79)	40.22(39.35)^{g}	26.50(30.23)^{g}	54.04
NSKE	7.11(15.45)^{cd}	15.55(23.15)^{d}	23.11(28.73)^{c}	27.89(31.82)^{d}	18.42(24.82)^{d}	68.05
K_2HPO_4	8.44(16.85)^{d}	20.22(27.42)^{fg}	30.44(33.46)^{e}	35.99(36.8.)^{f}	23.77(28.46)^{f}	58.78
Salicylic acid	6.66(14.89)^{b}	18.66(25.55)^{e}	26.66(31.05)^{d}	32.44(34.70)^{e}	21.11(26.48)^{e}	63.39
O.sanctum + *P.fluorescens* I_{18}	8.22(16.64)^{cd}	19.99 (26.42)^{ef}	31.99(34.39)^{ef}	35.11(36.33)^{f}	23.83(28.39)^{f}	58.67
NSKE + *P.fluorescens* I_{18}	6.22(14.42)^{a}	8.89(17.26)^{a}	11.99(20.18)^{a}	13.55(21.56)^{a}	10.16(18.38)^{a}	82.38
Carbendazim	5.99(14.06)^{a}	9.99(18.34)^{ab}	14.88(22.63)^{b}	17.76(24.88)^{bc}	12.16(20.02)^{b}	78.91
Control	34.88(36.15)^{e}	51.99(46.09)^{h}	65.33(53.91)^{g}	78.44(62.31)^{h}	57.66(49.63)^{h}	
Mean	10.02(17.61)^{A}	19.01(25.14)^{B}	26.64(30.38)^{C}	31.63d(33.70)^{D}		

WAS-Week after spraying; Values in parentheses represent arc sine transformed values, In the column, means followed by a common letter are not significantly different at 5% level by DMRT

Table 2. Survival of *Pseudomonas fluorescens* on bhendi leaves in the field trial

Treatment	Days after foliar application						
	0	1	7	14	21	28	Mean
P. fluorescens I_{18}	19.0[b]	25.25[b]	35.00[a]	51.25[a]	46.00[a]	27.0[a]	33.92[a]
P. fluorescens 1	16.25[dc]	20.00[d]	30.00[c]	40.50[c]	35.25[c]	20.75[c]	27.13[c]
O. sanctum + *P. fluorescens* I	15.0[b]	19.00[b]	22.50[b]	28.75[b]	23.50[b]	11.00[b]	19.96[d]
NSKE + *P. fluorescens* I_{18}	17.25[dc]	23.25[c]	32.00[b]	50.00[b]	44.25[b]	25.25[b]	32.00[b]
Control	4.00[e]	4.25[e]	3.5[e]	3.75[e]	3.50[e]	3.5[e]	3.75[e]
Mean	14.30[F]	18.35[D]	24.60[C]	34.85[A]	30.50[B]	17.50[F]	

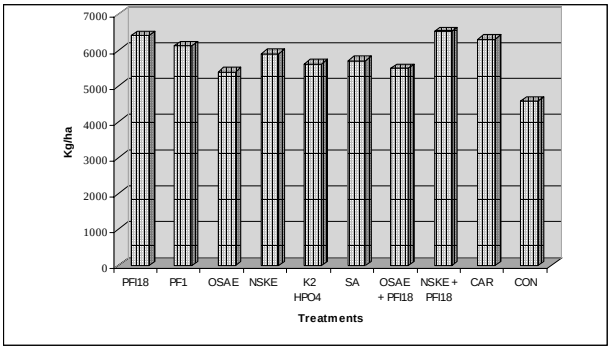
In the column, means followed by a common letter are not significantly different at 5% level by DMRT

the initial population in all the treatments except in *O. sanctum* + *P. fluorescens* I_{18} treatment

Bhendi fruits production

The treatments imposed for the control of powdery mildew were found to exert significant influence on the yield of bhendi fruits. All the treatments significantly increased the yield of bhendi fruits (Figure 1). As observed in the disease incidence reduction, the maximum yield was recorded in NSKE + *P. fluorescens* I_{18} followed by *P. fluorescens* I_{18}, carbendazim, *P. fluorescens* 1, NSKE, salicylic acid, K_2HPO_4, *O. sanctum* + *P. fluorescens* I_{18} and *O. sanctum* . It is interesting to note that except *O. sanctum*, all other treatments increased the yield by more than 20%.

Figure 1. Effect of biopesticides **(***P. fluorescens* I_{18} – PFI18, *P. fluorescens* 1 – PF1, *O. sanctum* – OSAE, neem seed kernel extract – NSKE) and chemical **(**Salicylic acid – SA, Carbendazim – CAR, Water - control**)** treatments on yield of bhendi fruits (Kr/ha)



DISCUSSION

Results revealed that spray application of NSKE + *P. fluorescens* I_{18} drastically reduce the powdery mildew disease incidence and increased the fruit yield compared to control followed by *P. fluorescens* $I_{18,}$ NSKE, salicylic acid and K_2HPO_4 treatments .Previously it was reported by Nallathambi *et al*. (2003) that spraying of native isolate of *P. fluorescens* (CIAH-196) combined with karathane resulted in 97.59% control of ber powdery mildew. *P. fluorescens* alsoreduce collar rot incidence of brinjal and significantly increased the fruit yield (18,165.78 Kg ha^{-1}) as compared to that of brinjal (8553.79 Kg ha^{-1}) (Jadon *et al*., 2007). Salicylic acid 10mM significantly (73.89%) inhibit the growth of Botrytis ricin Godfrey infection in castor (Kumar *et al*., 2007). Our results shows that salicylic acid even at 1mM reduce PMD by 63.39 per cent reveals its higher control efficiency. Ragupathi and Thamburaj (1990); Rettinassababady *et al*. (2000) found that NSKE (5%) was superior in containing the powdery mildew disease and increasing the yield of blackgram and Bhendi respectively. Present results also revealed that NSKE reduce more than 68 per cent powder mildew disease incidence. It was slightly reduced when salicylic acid as reported by Amaresh *et al*. (2001). They reported that salicylic acid treatment as foliar spray caused reduction in the root rot disease caused by *Rhizoctonia solani* in cowpea. The efficacy of phosphate and potassium salts in controlling powdery mildew of cucumber was reported by Reuveni *et al*. (1996).

Biological control has emerged as the most promising means for management of diseases. In recent years phylloplane bacteria having unique ability to survive in their host plant (Chowdhury and Verma, 1980; Beattie and Lindow, 1999; Mondal, (2004) and also holds great promise in the field of biological control (Mondal and Verma, 2002). One of the pre-requisites for the efficiency of biological control agents in controlling the plant diseases is their capacity to survive in the target sites. In the present study, when biopesticides sprayed either alone or in combination with plant extract on bhendi foliage, the population increased steadily upto 14 days and thereafter declined. Gnanamanickam and Mew (1992) stated that the

antagonists preoccupy the infection site and deprive the same to the pathogen. Beattie and Lindow (1999) reported that the bacterial multiplication and colonization depend on modification of leaf habitat, ingression and egression. The studies of Krishnamurthy and Gnanamanickam (1998) clearly demonstrated the survival of foliar applied *P. fluorescens* strain *Pf* 7-14 in rice up to 40 days. Mean *P. fluorescens* I18 establishment was maximum (33.92 5) on brinjal collar rot (Jadon *et al*., 2007). However, in the present study, the antagonist survived in phylloplane only for a period of fourteen days necessitating repeated application of the bio control agent for effective disease management.

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