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Impact of powdery mildew and sooty mold diseases on mango by natural fungicide

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Abstract

An investigation was carried out to determine the efficacy of some organic materials to manage powdery mildew and sooty mold diseases on mango, under natural field condition at Sharqia and Ismaelia governorates in Egypt. PlcoCure natural fungicide applied as foliar spray to find out its efficacy and profitability compared with control (no spray) and chemical fungicides Super sard potassium soap, Malathion, mineral oil to control sooty mold. All the treatments controlled the diseases significantly compared with control. As chemical, the PlcoCure showed significant impact on disease reduction. This natural fungicide gave a higher benefit with minimum production cost and this approach is proposed to the mango growing farmers to control the diseases. So, organic combination might be a better option to control powdery mildew and sooty mold diseases on mango rather than chemical control as it is cost-effective, environment friendly and good yield.

Keywords: Mango; Powdery mildew; Sooty mold; Chili oil; Garlic oil

1. Introduction

Mango (*Mangifera indica* L.) is an important fruit and is susceptible to a number of diseases at all stages of its development, i.e., from nursery to fruit bearing trees. All plant parts, namely, trunk, branch, twig, leaf, petiole, flower and fruit are attacked by different pathogens. Among the diseases, powdery mildew, caused by the fungus *Oidium mangiferae* Bert., was first reported from Brazil in 1914 by Berthet and subsequently it was reported in several other countries. The losses caused by this pathogen vary from 5-20% depending on the weather conditions. The affected fruits do not grow and may drop before attaining pea size [1]. The fungus is a biotrophic parasite, developing on live and susceptible tissues of the host plant. The pathogen survives in old leaves at non-favorable conditions, where it produces conidia, which will infect other leaves, flowers and fruits. It is characterized by a white, powdery mycelium growth on the affected parts. It can cause injures that, later, will favor infection by anthracnose [2]. Mango sooty mold (*Meliola mangiferae*) is a pathogen results from interactions among sap-feeding insects and nonparasitic fungi. These mold fungi do not infect the plant tissues their damage is cosmetic-yet the science of plant pathology treats them as plant diseases because of their negative effects on photosynthesis: they block sunlight from reaching leaf chloroplasts, where the plant "harvests the sun" and produces energy for growth. Sooty mold is also a significant postharvest problem for some vegetable and fruit commodities. The disease creates aesthetically disagreeable fruit spots that reduce the produce's quality, grade, and marketability [3]

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Garlic (*Allium sativum* L.) is an edible plant which has been employed extensively as a spice since ancient times .The potential antimicrobial activities of garlic constituents have been investigated for a longtime. Louis Pasteur, for instance, investigated the antimicrobial potential of garlic. Organ sulfur compounds, especially allicin, derived from garlic are excellent antimicrobial agents with a broad spectrum of biological activities against several bacteria (both Gram-positive and Gram-negative), fungi, protozoa and viruses [4],[5].Various studies have confirmed that thiol modification of glutathione and proteins is crucial for understanding the antimicrobial mode of action of allicin [6], [7]There are several mechanisms that contribute to the resistance to allicin in bacteria like the Mercuric reductase MerA proteins, which seem to be able to detoxify allicin by reduction. A genomic cluster conveying the resistance has been identified employing a highly allicin-resistant *Pseudomonas fluorescens*strain isolated from garlic [8]Recently, allicin, because of its oxidizing nature, has been reported to induce apoptosis in yeast cells [7] an alternative cell-killing mechanism to the formerly suggested specific oxidative inactivation of crucial enzymes ([6] [9]

The present investigation aimed to study and evaluate alternative fungicide for getting rid of powdery mildew and Mango sooty mold in comparison with classic fungicides on five verities of mango.

2. Material and methods

Table 1 Chemical Fungicides and Alternative fungicide used

Trade Name	Active ingredient	rate
Super Masrona94%	Mineral oil	1.5 ML /L
Super sardo 50% SC	Azoxystrobin	25 cm^3/100L
Agriculture Potassium Soap	Slavonic acid +potassium hydroxide	1ml/L of water
Actathion 57% EC	Malathion	1ml/L of water
PlcoCure	garlic oil + chili oil +cupper15%+ sulfur 10%	L/300 L water

2.1 Field experiments

The experiment was conducted at Sharqia and Ismaelia, Governorates with six treatments of different fungicides, *viz.,* Malathion, mineral oil of water, potassium soap, natural fungicide Plco Cure was obtained from Pure Life Fertilizers Company and water alone with one untreated Control on five verities (Ewees, Hendy, Langra , Ket and Naomy) mango plantations in case of the powdery mildew and Mango sooty mold1000 square meter area was selected for each treatment. Two sprays were taken up at 15 days interval during flowering stage (in the month of October). The experiment was laid out in randomized block design with four replications. The observations on powdery mildew diseases were recorded before and after each spray. Observations on mango sooty mold disease were recorded seven days after the first spray. Ten plants were examined randomly and scored of mango sooty mold disease severity is following 0-5 scale. The details of scales are as shown below; also the yield of each treatment was recorded.

- No disease symptoms,
- Up to 10 per cent leaf / stem / inflorescence/ fruit area infected,
- 11-25 per cent leaf / stem / fruit area infected,
- 26-50 per cent leaf / stem / fruit area infected,
- More than 50 per cent leaf / stem / fruit area infected, and
- Complete drying of leaf / stem / fruit.

Further, the scale was converted into severity (Per cent Disease Index i.e. PDI) using the formula [10] PDI = (Sum of numerical rating / Total number of leaves examined) × (100 / Maximum grade value)

2.2 Survey of mango powdery mildew disease

Survey of mango powdery mildew, downy mildew and Mango sooty mold diseases incidence and severity has been carried out in Ismaelia and Sharqia governorates in Egypt from October until May of successive growing seasons and five verities were selected and taken into consideration to detect the disease incidence and its severity symptoms on the different plant parts. The diseased, inflorescences, panicles and leaves were described. Panicles were rated on a scale of 0-4 for the disease severity using the following scale described by [11]**,** where: 1= panicle frees of disease, 2= 1-

25% infections, 3= 26-50% infection, 4=51-75%infection and 5= more than 75% infection. Percentages of disease incidence and sum of all the disease rating are calculated using the following equations:

$$\text{Disease incidence (\%)} = \frac{\text{No. of diseased plants}}{\text{Total No. of examined plants}} \times 100$$

$$\text{Percent of disease intensity (PDI)} = \frac{\text{Sum of plant x degree of disease scale}}{\text{No. of plants investigated x maximum disease grade}} \times 100$$

2.3 Statistical analysis

Disease severity was statistically analyzed as a complete randomized block design and multiple F test [12] using Web Agri. Stat Package Computer Program (WASP).

3. Results

Table 2 Effect of field application of fungicides and natural fungicide on % disease severity and % efficacy of powdery mildew disease in varieties of mango in two governorates

Treatments			Super sardo	Plco Cure	control	Treatments			Super sardo	Plco Cure	control
varieties of mango in Sharqia governorate	Ewes	disease severity%	20^{c}	15^{d}	50^{a}	varieties of mango in Ismaelia governorate	Ewes	disease severity%	7^{c}	3^{d}	31^{a}
		%efficacy	60	70	//////			%efficacy	77.4	90.3	/////////
	Naom	disease severity%	15^{c}	12^{d}	43^{a}		Naom	disease severity%	8^{c}	3^{d}	35^{a}
		%efficacy	65	72				%efficacy	77	91	////////
	Langara	disease severity%	16^{c}	12^{d}	45^{a}		Langara	disease severity%	7^{c}	2^{d}	32^{a}
		%efficacy	64.4	73.3				%efficacy	78	93.75	///////
	Ket	disease severity%	6^{c}	3^{d}	35^{a}		Ket	disease severity%	8^{c}	4^{d}	33^{a}
		%efficacy	83	91				%efficacy	75.7	87.87	////////
	Hendy	disease severity%	16^{c}	13^{d}	45^{a}		Hendy	disease severity%	6^{c}	3^{d}	35^{a}
		%efficacy	64.6	71				%efficacy	83	91	/////////

Data in table (2) showed that all treatments reduced % disease severity significantly but the Plco Cure gave the highest efficacy in controlling powdery mildew in mango whether in Sharqia or in Ismaelia governorate .hence Plco Cure gave in Sharqia governorate (70,72,73,91 and 71) and in Esmaelia governorate(90.3,91,93.75,87.87 and 91%) efficacy in all

varieties of mango (ewes , naom, langara , ket and hendy), respectively in the same way in table (3) the mean of the yield per fadan was obviously in high level with Super sardo and PlcoCure in comparison with control.

Table 3 Effect of field application of fungicides and natural fungicide on means of yield ton/fadan in controlling powdery mildew disease in varieties of mango in two governorates

Treatments	Ewes		Naom		Langara		Ket		Hendy	
	Sharqia	Ismaelia	Sharqia	Ismaelia	Sharqia	Ismaelia	Sharqia	Ismaelia	Sharqia	Ismaelia
Super sardo	4[a]	4.3[a]	4.9[a]	5.2[a]	4[a]	4.5[a]	4.5[a]	4.7[a]	3[a]	3.5[a]
Plco Cure	3.8[a]	4.1[a]	4.7[a]	5.2[a]	3.8[a]	4.5[a]	4.4[a]	4.5[a]	2.9[a]	3.2[a]
control	3.1[b]	3.2[b]	3.5[b]	4.3[b]	3[b]	3.8[b]	3.5[b]	3.8[b]	2.5[b]	2.7[b]

Table 4 Effect of field application of fungicides and natural fungicide on % disease severity and % efficacy of sooty mold disease in varieties of mango in two governorates

Treatments			Mineral oil	malathion	potassium soap	Plco Cure	Control				Mineral oil	Malathion	Potassium soap	Plco Cure	Control
varieties of mango in Sharqia governorate	Ewes	disease severity%	23[b]	15[c]	20[b]	13[d]	44[a]	varieties of mango in Ismaelia governorate	Ewes	disease severity%	25[b]	20[c]	23[b]	15[d]	45[a]
		%efficacy	47.7	66	54.54	70.5	////////			%efficacy	45	55	49	66	///////
	Naom	disease severity%	20[b]	18[c]	18[b]	11[d]	39[a]		Naom	disease severity%	23[b]	18[c]	20[b]	12[d]	40[a]
		%efficacy	48.7	53.8	53.8	72	///////			%efficacy	42.5	55	50	70	///////
	Langara	disease severity%	18[b]	10[c]	15[b]	8[d]	36[a]		Langara	disease severity%	21[b]	19[c]	21[b]	12[d]	42[a]
		%efficacy	50	72	58.3	77.7	/////			%efficacy	50	54.8	50	71.4	////////
	Ket	disease severity%	23[b]	15[c]	18[b]	10[d]	40[a]		Ket	disease severity%	28[b]	16[c]	26[b]	14[d]	46[a]
		%efficacy	42.5	62.5	55	75	///////			%efficacy	39	65.2	43.5	70	//////
	Hendy	disease severity%	16[b]	14[c]	17[b]	8[d]	38[a]		Hendy	disease severity%	26[b]	20[c]	23[b]	11[d]	42[a]
		%efficacy	58	63	55.2	79	///////			%efficacy	38	52.4	45	74	///////

Data in table (4) gave also high effect of Plco Cure to control sooty mold disease compared with control and other treatment the percentage of efficacy were in Sharqia governorate(70.5, 72, 77.7, 75 and 79) and Ismaelia governorate (66,70,71.4,70 and 74 %) efficacy in all varieties of mango (ewes ,naom, langara, ket and hendy), respectively.

Data in table (5) recorded the high level of yield in treatment Malathion and Plco Cure in comparison with all treatment and there was a significant difference between natural fungicide and control.

Table 5 Effect of field application of fungicides and natural fungicide on means of yield ton/fadan in controlling sooty mold disease in varieties of mango in two governorates

Treatments	Ewes		Naom		Langara		Ket		Hendy	
	Sharqia	Ismaelia	Sharqia	Ismaelia	Sharqia	Ismaelia	Sharqia	Ismaelia	Sharqia	Ismaelia
Mineral oil	3.4^{c}	5.6^{c}	4.6^{b}	5.8^{b}	3.7^{b}	5.5^{c}	4^{b}	4^{c}	3^{b}	3^{b}
Malathion	3.8^{b}	6^{b}	4.6^{b}	6^{b}	4.3^{a}	5.8^{b}	4.9^{a}	4.7^{a}	3^{b}	3.2^{b}
potassium soap	3.6^{bc}	5.3^{bc}	4^{c}	5.5^{c}	3.9^{b}	5.3^{d}	4^{b}	4.3^{b}	3^{b}	3^{b}
Plco Cure	4.5^{a}	6.5^{a}	4.9^{a}	6.5^{a}	4.4^{a}	6^{a}	4.9^{a}	5^{a}	3.5^{a}	3.7^{a}
control	2.8^{d}	4.5^{d}	3.5^{d}	4.3^{d}	3^{c}	4.2^{e}	3.5^{c}	3.8^{d}	2.5^{c}	2.7^{c}

4. Discussion

In this study, results indicated that disease incidence and severity of powdery mildew and sooty mold on mango, were significantly decreased by spraying natural fungicides which contains some essential oils: garlic and chili The results showed that Plco Cure treatment significantly surpassed others in most cases and the essential oils treatments gave best results with those obtained when the fungicide Super sardo, Malathion and mineral oil were used. These findings could be explained according to previous authors who stated that essential oils have important ecological functions. One of these functions is to protect the plant against infection by pathogens [13]; [14]. In addition, they found that oil treatment caused plasma membrane disruption and mitochondrial structure disorganization [15]. [16]. antifungal compounds and fungitoxic agents that can inhibit the growth of certain microorganisms [17-25]

In this study, the antifungal activity of allicin which is the active ingredient of garlic acid. More than half a century ago, allicin was evident as an inhibitor of several thiol-possessing enzymes, and glutathione overturned the inhibitory effect of allicin, which simply elucidated the principle of a nonspecific mechanism of action of allicin that includes its covalent bonding with the thiol groups in enzymes [26]With reference to previously described modes of action, another study confirmed the interaction of allicin with protein thiol group sand also reported the diffusion of allicin across lipid bilayers [27]and [28]

[29]found that , At the MIC, the leaf extract revealed a potent activity against *A. flavus* (88.06%), while the fruit extract revealed activity against *A. niger* (88.33%) in the well diffusion method. Groundnut seeds treated with *Capsicum* sp fruit extract displayed an advanced rate of fungal inhibition [30]. Moreover, the peptides obtained from chili pepper seeds hindered the development of the yeasts *Saccharomyces cerevisiae, Candida albicans, C. parapsilosis, C. tropicalis, Pichia membranifaciens, Kluyveromycesmarxiannus, and C. guilliermondii.* The peptide fraction displayed a potent fungicidal activity against *C. albicans, Saccharomyces cerevisiae, and Schizosaccharomycespombe,* and also fostered numerous morphological differences to *C. albicans*. It also decreased the glucose-activated acidification of the medium facilitated by the H (+)-ATPase of S. cerevisiae cells in a concentration-dependent approach and resulted in the permeabilization of the yeast membrane to the dye SYTOX Green, as established by confocal laser microscopy [29]. Also we found that all organic treatments did not have an insect infection such as red spider and white fly.

5. Conclusion

In summary, the current investigation uncovers the potential antifungal activities of natural fungicide against a variety of pathogenic fungi. The main aim of the study was to exploit this organic compound as a potential antifungal agent against abroad spectrum of plant pathogens. The antifungal activity of allicin and capsicum was explored by employing different kinds of assays. Allicin and capsicum showed promising antifungal activities against these Pathogens and insects also hence this compound is co-friend with an environment in addition to the low costs of using it.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest.

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