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PROS AND CONS OF FUNGICIDES: AN OVERVIEW

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ABSTRACT

Many contact and systemic fungicides are used to control plant pathogens to get disease free crop. Farmers use these chemicals to protect their crop like plantation crop, fiber crop, vegetable and fruit crops etc., from plant pathogenic fungi and their toxins which destroy their entire crop and finally economic loss occurred. But these fungicides also affect soil microorganisms like decomposers and mycorrhizal fungi etc. Fungicides also show hazardous affect on human health. Soil and water pollution occur due to use of fungicides. Many fungi also play an important role in soil in increasing soil fertility. Some fungi like Trichoderma, Penicillium, Aspergillus etc., show antagonistic effect against plant pathogen. These beneficial microorganisms kill by using fungicides. Instead of using fungicides we should use some plant extracts and biocontrol agents which show antimicrobial activity. If biocontrol agents, botanicals as well as nano-materials are used to control plant pathogens, we can save our environment from pollution to get healthy environment for all living beings.

KEYWORDS: Bio-agents, botanicals, fungicides, fungi, soil microflora.

INTRODUCTION

PROS OF FUNGICIDES

Fungicides are well known to control many plant pathogenic fungi. Chemical technology has expanded tremendously during the last fifteen years with an estimated 100,000 chemicals produced and used commercially and about 17% of applied pesticides are fungicides [1,2]. Fungicides are used extensively in modern agriculture for the control of fungal pathogens. Fungicides (contact as well as systemic) are used to kill the plant pathogenic fungi and protect the plants, hence they play a very important role. Malathi and Jeyarajan[3] reported that chlorothalonil and mancozeb effectively reduced mycelial growth of *P. infestans* with lower concentration of chlorothalonil was more effective than the equivalent conc. of mancozeb. Many contact fungicides like metiram 70% WG and mancozeb 75% WP and systemic fungicides like dimethomorph 50%WP, fenamidone 50% WP, curzate (cymoxanil 8% + mancozeb 64%) and ridomyl M_2 72% WP (metalaxyl 8% + mancozeb 64%) were found to be highly effective against *Phytophthora infestans.* Systemic fungicides are highly effective even at low concentration and many fungicides are also used prophylactically to protect the crop from fungi[4,5,6] . Wong and Wilcox[7] reported that mancozeb provided complete control of grapevine downy mildew pathogen; *Plasmopara viticola.* Finamidone provided cent percent inhibition against *Plasmopara viticola, P. infestans, Pseudoperonospora cubensis and Bremia lactucae*[8]. When dimethomorph applied on crop (potato and cucumber) before inoculation of late blight and downy mildew pathogens respectively, provide complete protection from these pathogens[9]. Carbendazim (systemic fungicide) and mancozeb (dithiocarbamate, contact fungicide) were widely used to control fungal diseases of many plants particularly Mancozeb, in the initial vegetation stages[4,6].

CONS OF FUNGICIDES

Fungicides also show negative effects in our environment and decline in the number of soil fungi. A.K. Shukla[10] reported that fungicides affect hyphal growth and enzyme activity of microorganisms, which are responsible for decomposition of pesticides. Some fungicides are toxic for non target microorganisms like AMF (Arbuscular Mycorrhyzal Fungi), *Tirchoderma*, beneficial bacteria, algae etc. Microorganisms play an important role in many soil biological processes, including nitrogen transformations, organic matter decomposition, nutrient release and

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their availability, as well as stabilize the soil structure and affect its fertility, soil texture[11,12,13]. Soil microflora is the first biota that undergoes direct and indirect impacts of toxic substances introduced to soil. Microorganisms are used as biomarkers and reflect the negative activity of pesticides and commonly used in ecotoxicological tests[14,15,16].

This is true that pesticides like fungicides, insecticides, herbicides etc. effectively play an important role in controlling plant pathogenic organisms but these pesticides also affect soil texture, soil microorganisms and cause water pollution as well as soil pollution. Margni[17] observed that changes in the soil activity depending on the intensity and spectrum of activity as well as persistence of the parent chemicals or its metabolites. Pesticides affect microorganisms by reducing their numbers, biochemical activity, diversity and changing the microbial community structure[18,19,20]. The toxic effect of pesticides may be toxic to many soil microorganisms because they can penetrate the cell, disturb the microbial metabolism often cause the death of sensitive part of microbial populations. In 2008 Doignon and Rozes[21] reported that the triazole fungicide (Flusilazole) modified the sterol content of *Saccharomyces cerevisiae.* The plasma membrane fluidity was altered by the presence of methyl sterol which increased with the flusilazole concentration, thus affect the microorganisms. Many chemicals affect biochemical processes and fertility of the soil[22].

The herbicides and fungicide were most effective in reducing the number of microorganisms. The inhibition in growth in microorganisms was gradually increased in presence fungicide- Carbendazim and herbicides 2,4-D and Metribuzin-4-amino-6-tert-butyl-3-methylsulfanyl-1,2,4-triazin-5-one[23]. Bending[24] reported that some pesticides significantly reduce mineralization of subsequent application of other pesticides. Microbial activities are affected by chemicals intensively used in agriculture[25]. According to Pozo[26] denitrified bacteria and aerobic diazotrophs were significantly declined by the application of mancozeb and pesticides also effect on bacteria and actinomycetes. Cellulase as well as pectinase activity was significantly lowered by the application of mancozeb[27,28]. Kjoller and Rosendah[29] observed that fungicides restricted the development of AMF. Narender[30] observed that the fungicides significantly inhibited the colonization of mycorrhizal fungi. Application of fungicides (Chloroflorochlorine, Acrobat and Ridomyl gold) in normal soil caused reduction in soil spore density and their root infection intensity in wheat crop. Wheat yield, yield components and plant nutrients uptake decreased by the application of different fungicides as compared with the treatment applied with no fungicides[31]. Fungicide - Carbendazim, Herbicides 2,4-D and Metribuzim) used drastically reduced the number of bacteria, fungi, actinomycetes, and beneficial microflora i.e., azotobacter, azospirillum and Phosphate Solubilizing Bacteria (PSB) in treated soil compared with the untreated soil. Colonies decreased with application of fungicide and herbicides[23].

Use of biocontrol agents:

Many microorganisms show antifungal and antibacterial activity and called biopesticides[32].The biocontrol mechanisms exercised by *Trichoderma* could be attributed to competition for nutrients, release of extracellular hydrolytic enzymes, and secondary metabolites toxic to plant pathogens at very low concentrations. *T.virens*[33]. Similar observation was made by Becktell[34] who was reported that bio-agents *T. harzianum* and *Gliocladium virens* were ineffective against tomato late blight.

Trichoderma induces defence responses in host plants (e.g., Systemic Acquired Resistance)[33]. In particular, *T. harzianum* produces a variety of antibiotic antifungal peptides that interact with cell membranes of plant fungal pathogens, so inhibiting their growth[35]. Furthermore, *T. harzianum* inhibit wood rots and other fungal plant pathogens by up to 60% through production of volatile antibiotics[36]. *Trichoderma* spp. can also attack and parasitize other fungi directly. Plant root system is even more efficient, by *Trichoderma* enhanced root growth and development. Its use allows reducing the nursery bench time, mineral fertilization and fungicide applications, and getting larger leaves and stems as well as faster rooting in outdoor conditions[37,33,36,38]. Beneficial effects, in particular of some *Glomeromicota* spp. fungi, have been reported on growth, tissue hydration and leaf physiology. Anju Rani[39] reported that *Aspergillus fumigates, A. niger, Penicillium funiculosum, P. citrinum, P. aurantiogriseum* and *Trichoderma koningii* were effective against plant pathogenic fungi *Phytophthora infestans*.

Many workers [37,40,41] reported that plant pathogens significantly affected by bioagents. The use of certain bacteria or yeasts to control pre- and post-harvest pathogens and pests of agricultural commodities found to be effective[42,43]. Mateo[44] showed prochloraz to be the most active antifungal agent against *F. langsethiae in vitro*. There have been several reports showing growth inhibition of fungal pathogens treated with bacterial strains like *Bacillus amyloliquefaciens*, *Microbacterium oleovorans*, *Amphibacillus xylanus* and *Sporolactobacillus*

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inulinus[45,42,46,43]. The use of bio-control agents with antagonistic effects on the main maize pathogens could represent good alternative[46]. Bacon[47] described *B. subtilis* and *F. verticillioides* as ecological homologues occupying the same ecological niche. Furthermore, *B. subtilis* has been shown to control *A. flavus* and aflatoxin production both in the field and during storage[48,45]. So there is a need to use biopesticides to secure environment[49].

Use of plant extracts:

The use of chemicals or synthetic chemical fungicides are being used successfully but indiscriminate use of these chemicals led to have development of fungicides resistance and cause environmental pollution and adversely affect on animals and human health by producing undesirable side effects due to their carcinogenic properties[50]. Considering the adverse and alarming effects of synthetic pesticides on environment and natural habitats and the promotion of environmentally sustainable and organic agriculture, fungicide alternatives such as the use of natural plant products is needed[51,52]. Plants contain antimicrobial compounds which can be toxic to pathogens and these natural plant products can be used to control plant diseases. Contrary to the problems associated with the use of synthetic chemicals, botanical extracts are environmentally non pollutive, renewable, inexhaustible, indigenously available, easily accessible, largely non phytotoxic, systemic ephemeral, thus readily biodegradable, relatively cost effective and hence constituted as suitable plant protecting agents in the strategy of disease management[53]. Plant extracts or biopesticides having antimicrobial activity due to presence of terpenoids, essential oils, phenolics and polyphenols, alkaloids and polypeptides and called natural products. Biopesticides are ecofriendly[54,32]

There are many botanical fungicides like Cinnamaldehyde, Gamma-aminobutyric acid (GABA), Jojoba oil, Laminarin etc. and essential oils obtained from *Calocedrus macrolepis* var. *formosana* , *O. acutidens,* cymbopogan (*Cymbopogon citrates*), *Ocimum gratissimum*, *Thymus vulgaris*, Bergamot (*Citrus hystrix*), tea tree (*Melaleuca alternifolia*) and *Asarum heterotropoides* var. *mandshuricum* show antimicrobial activity against *Amaranthus retroflexus*, *Chenopodium album*, and *Rumex crispus, S. sclerotiorum, Rhizoctonia solani, Rhizopus stolonifer*, *Mucor* spp, *A. brassicicola*, *A. flavus*, *Bipolaris oryzae*, *F. moniliforme*, *F. oxysporum*, *F. proliferatum*, *M. oryzae*, *A. humicola*, *Colletotrichum. gloeosporioides*, and *Phytophthora cactorum*[55,56,57,58,59,60] . Ngadze[61] reported that *A.sativum* and *C. papaya* leaf extracts can be used effectively instead of fungicides in the control of late blight in potato. According to Anju Rani[62] there is a possibility of integrating neem extracts in overall plant pathogen management strategy with a view to avoid development of fungicide resistance in *Phytophthora infestans.* Efficacy of plant extracts against *P.infestans* has been demonstrated by several workers[63,64,65,66]. Mungkornasawakul [67] tested dry and powdered rhizome extracts of *A. calamus* against *Alternaria* spp. (leaf spot) and *Fusarium* spp. (wilt of cruciferous vegetable) as well as *Botrytis* spp. (gray mold rot of roses) and S*eptoria* spp. (leaf spot of chrysanthemum) and their results indicated that all the examined pathogens were sensitive to *A.calamus* extract. Phongpaichit [68] reported that *A. calamus* exhibited high activity against *Trichophyton rubrum*, *Microsporum gypseum* and *Penicillium marneffei*. The extracts of *A. calamus* have been found to possess anti bacterial and antifungal activity also [69,70,71,66].

CONCLUSION

Fungicides are widely used to protect agricultural and horticultural crops from plant pathogenic fungi. Farmers purchase fungicides at how any cost to protect their crops but mostly fungicides affect adversely on soil fertility, soil microorganisms and other organisms like earthworms and even biological nitrogen fixing bacteria and algae also affected by the use of fungicides. Fungicides also cause pollution. Instead of using fungicides farmers should use Biopesticides (biocontrol agents and plant extracts) but these sources should be provided by government authorizing agencies commercially at very cheap rates comparison to fungicides to the farmers. So that our environment and living world will be safe.

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