The Planta RBS: Vol.-2 Issue-1 (April) 2021: 500 - 506
(Research Book Series – www.pgrindias.in)

29

MANAGEMENT OF RUST DISEASE USING BOTANICAL FUNGICIDES[#]

Suhas Kundlik Kamble[1] and Yuvraj Dhondiram Kengar[2]

Abstract

The traditional approaches of disease control by means of chemical fungicides are unsafe to ecosystem and human beings too. The use of chemical fungicides is worldwide to control fungal diseases. An application of chemicals leads to the development of resistance in pathogen and affection to the soil micro-flora. On the other hand, the high cost of fungicides and their threats to human health and environmental pollution have encouraged an investigation of alternative strategies for the control of pest and pathogens. The control of diseases with the help of plant extracts is chief and safe method for famers. The present review article is focusing on management of rust diseases by means of phytofungicides.

[#]General Article

[1]Department of Botany, Dahiwadi College Dahiwadi, Tal- Man, Dist- Satara 415508, Maharashtra, [2]Department of Botany, Dahiwadi, Smt. Kusumtai Rajarambapu Patil Kanya Mahavidyalaya, Islampur, Dist. Sangli 415409, Maharashtra, India.
E-mail: suhaskamble272@gmail.com

Introduction

The fungal pathogens cause various symptoms such as vascular wilt, yellows, corm root, root rot, damping-off and rust. Thus, the presence of these microorganisms in crops, vegetables, and fruits has a considerable impact on the value of foods and related products (Ritchie, 1985). Fungi are significant destroyers of foodstuffs and grains during storage, demonstrated them unfit for human consumption by retarding their nutritive value and generating mycotoxins (Marin et al., 1999; Janardhana et al., 1998; Park et al., 2004; Koirala et al., 2005; Domijan et al., 2005). In the different regions of the world, billions of dollars of toxic pesticides are employed every year for the control of plant diseases and the agents applied for the same may pollute water and terrestrial environments for long periods (Agrios, 1997). Rusts diseases of plants are caused by pathogenic fungi belongs to Pucciniales. There are about 168 genera and around 7000 species of rust pathogen. An infection is appears on the leaves, petioles, tender shoots, stem, fruits etc. Plants become stunted, chlorotic or discolored due to the severe rust infection. Rust sporulates on affected plant parts (Savile, 1976, Kirk et al., 2001 & Mohanan, 2010). All rusts are obligate parasites, since they require a living host to complete their life cycle. They habitually do not kill the host plant but can severely reduce their growth and yield (Central Science Laboratory, 2006). The symptoms comprise leaf necrosis lacking defoliation. An infection can result in non-viable seed, pod detachment, low yields and oil content (Hammons, 1977; Nutter and Shokes, 1995). Rust fungi are classified by spore types produced during the life cycle. Fungi that produce all five spores (occasionally excluding pycniospores) are termed macrocyclic and those lack pycniospores and aeciospores in their life cycle termed as microcyclic and all the time have an autoecious life cycle. Demicyclic fungi delete the repeating uredial stage from the life cycle.

Management of Rust Disease using Chemical Fungicides

The foliar applications of fungicides have been reported for effective reduction of rust spread (Smith and Littrell 1980, Mayee, 1982). Gupta and Shyam (1998) were tested the efficacy of Triademefon, Hexaconazole, Difenaconazole, Fenarimol, Penconazole, Flusilazole, Mancozeb and Chlorothalonil against rust of pea. Mancozeb and chlorothalonil have been reported better-quality for the inhibition Puccinia helianthi Schwein. (Amaresh and Nargund, 2003). Gonzalez et al. (1977) also reported good control of rust in Costa Rica with Mancozeb & Captafol. Singh et al. (2004) have reported that foliar application of Dithane M-45, when started with appearance of the disease and repeated twice or thrice at an interval of 10 days was most effective in reducing rust severity and increasing yield. Brahma et al. (1991) revealed that the fungicide Propiconazole was found efficient against all rust. Pyracarbolid, Plantvax and Triforine to be effective against bean rust. Srivastava (1999) used 7 fungicides Bavistin (carbendazim), Captafol (captan), Topsin-M (thiophanate-methyle), Wettable Sulfur, cumin-L (ziram), Dithane M-45 (mancozeb) and Kavach (chlorothalonill), to control rust of rice bean (Vigna umbellate cv. RBL-1) rust caused by Uromyces appendiculatus F. Strauss under field.

Disadvantages of Chemical Fungicides

According to Lyon *et al.* (1995), the disease is commonly controlled by conventional fungicides applied as a foliar spray. However, the high cost of fungicides and the threats of environmental pollution have encouraged an investigation of alternative strategies for the control of pest and pathogens. The use of chemical pesticides is a very popular practice to control different plant diseases management as compared to natural one, prepared from plants or plant parts. But, consumers now demand the less use of synthetic fungicides because of the non-biodegradability, pollutive nature and residual toxicities of chemical pesticides. This resulted in alternative approaches which are economically reasonable and eco-friendly like botanical pesticides to control the disease (Ansari, 1995). Fungicide toxicity is not constantly restricted to the target pest organism, having also been verified in mammals including humans (Belpoggi *et al.,* 2002; Mendes *et al.,* 2005).

Role of Secondary Metabolites in Defense Of Diseases

Numerous plants and their products have been utilized for the control of plant disease. These are proved to be harmless and non-toxic unlike that of chemical fungicides (Khalil, 2001; Bowers and Locke, 2000; Satish *et al.*, 2009). Plants have the ability to synthesize secondary metabolites, like phenols, phenolic acids, quinones, flavones, flavonoids, flavonols, tannins and coumarins (Cowan 1999). The phenolic components such as carvacrol, eugenol, thymol *etc.* were extremely active for the control of pathogen. These groups of compounds show the antimicrobial effect and serves as plant defense mechanisms against pathogenic microorganisms (Das *et al.,* 2010).

Material and Methods to Control Rust

The Collection of Plants as a Source of Extract

The criteria for the selection of plants for source of extract

i. Mostly, weeds those having less economic value.
ii. The plants resistant to rust infection.
iii. The non-toxic plants for crop, animals and human being.
iv. The plants easily available to farmer in and around the agricultural fields.

Preparation of Plant Extracts

The plant parts such as leaves or bulbs washed with tap water for few times and blotted to dry. 100 grams of each selected plant material was crushed in a mortar and pestle with 100 ml sterile distilled water. The extract should be filtered through four layered muslin cloth. The filtrate has to be centrifuged at 1600 RPM for 5 minutes to avoid debris.

Standardization of Concentrations

The concentrations such as 1, 5, 15 and 20 % prepared by adding distilled water. These concentrations of plant extracts were increased up to get better results. The highest

concentration of plant extract at which inhibition of urediospore germination takes place selected for the experiment.

Field Experiments

Randomized Block Design

An experiment should be arranged with ten treatments and three replications with 1x 1 m plot size. Chemical fungicides like Propiconazole, Hexaconazole, Bavistin (carbendazim), Captafol (captan), Topsin-M (thiophanate-methyle), Wettable Sulfur, cumin-L (ziram), Dithane M-45 (mancozeb) etc. with different concentrations used as a standard check and water spray or without spray as a control. The sprayings should carry out after definite intervals of time against rust infected crops.

Evaluation of Disease Intensity

The efficacy of each phytofungicide was tested as compared to control plot sprayed with water. The intensity of disease was recorded by selecting five plants at random from each of the plot was selected for recording observations. From each plant, five leaflets from top, middle and bottom portions were chosen for recording observation. The percent disease intensity was examined by using 0-9 scale (Mayee and Datar, 1986).

Further, the percent disease index (PDI) and percent disease control (PDC) of the rust developed from the natural inoculums were observed at certain days interval after the appearance of the first symptoms and calculated by using Wheeler's (1969) formula.

Botanical Fungicides against Rust Disease

A number of studies have revealed the plant extracts as a source of natural pesticides that make outstanding efforts for new pesticide growth (Gangadevi *et. al*., 2008; Brindha *et. al*., 2009). Monda *et al.,* (2009), evaluated the efficacy Neem (*Azadirachta indica* A. Juss) derivatives (Neem oil, Neem cake and Neem leaf powder) and leaf extracts of pawpaw (*Carica papaya* L), stinging Nettle (*Urtica massaica* L) and Tobacco (*Nicotiana tabacum* L.) against bean rust. Yasser *et al.* (2016) showed that application of neem, clove and garden quinine extracts absolutely prevented rust development on wheat and was as good as that of the fungicide. According to Mekonnen *et al.* (2014) *Lantana camara* L., *Milletia ferruginea* L., *Eucalyptus globules* L., *Maesa lanceolata* L*, Ruta chalapensis* L.*, Vernonia amygdalina* L. and *Datura stramonium* L*.* exhibited potential efficiency against spearmint leaf rust in field condition. Pawar (2013) proved the efficacy of aqueous extract of *Azadirachta indica* and *Argemone mexicana* against jowor rust. Chandrashekara *et al.* (2012) used extracts of *Azadirachta indica, Carica papaya, Ocimum sanctum, Phyllanthus niruri* and *Vitex nigundo* against leaf rust of mulberry. Subramani *et al.* (2012) reported better efficiency leaf extracts of *Adathoda vasica, Lantana camara* and *Azadirachta indica* against rust of coffee. According to Anjorin and Samuel (2015) *Hyptis suaveolens* showed good activities against rust of cowpea and thus suggested *H. suaveolens* as an alternative to synthetic pesticides. Kamble and Patil (2019) has effectively controlled groundnut rust disease caused by Puccinia arachidis Speg. using foliar spray applications of plant extracts under field condition. They also prepared a new formulation, 'Panchaparni extract' by using leaf extracts of *Eupatorium odoratum* L., *Eucalyptus globulus* Labill., *Azadirachta indica* A. Juss., *Vitex nigundo* L. and *Datura metel* L. to control rust of groundnut which was found

to be most effective than all other plant treatments. Naz *et al.* (2014) tested aqueous leaf extracts of *Jacaranda mimosifolia, Thevetia peruviana* and *Calotropis procera* to control leaf rust of wheat. Manjappa (2015) found that aqueous extract of *Eupatorium odoratum* L. successfully controlled the blast disease of rice in field trails. Monda *et al.* (2009) studied the inhibitory effects *Azadirachta indica* A. Juss., *Carica papaya* L, *Urtica massaica* L. and *Nicotiana tabacum* L. against bean rust in field.

References

Agrios G. N. (1997), Plant Pathology, 4th ed., Academic Press, San Diego, California.

Amaresh Y. S. and Nargund V. B. (2003), Effect of some plant extracts on uredospores germination of *Puccinia helianthi* causing rust of sunflower. *Plant Disease Research,* 18(1):88-89.

Anjorin and Samuel T. (2015), Effect of mint weed (*Hyptis suaveolens* L. Poit) leaf extract on the incidence and severity of aphids infestation and rust disease of cowpea (*Vigna unguiculata* L. Walp). *African Journal of Agricultural Science and Technology,* 3(10):434-439.

Ansari M. M. (1995), Control of sheath blight of rice by plant extracts. *Indian Phytopathology,* 48(3):268-270.

Belpoggi F., Soffritti M., Guarino M., Lambertini L., Cevolani D. and Maltoni C. (2002), Results of long-term experimental studies on the carcinogenicity of ethylenebis-dithiocarbamate (mancozeb) in rats. *Annual New York Academic Science*, 982:123-136.

Bowers J. H. and Locke (2000), Effect of botanical extracts on the population density of Fusarium oxysporum in soil and control of *Fusarium* wilt in the green house. *Plant Disease*, 3: 300-305.

Brahma R. N., Asir R. and Aloka S. (1991), Efficacy of tilt (Propiconazole) on different wheat cultivars. *Indian Phytopathology,* 44:116-118.

Brindha V., Saravanan A. and Manimekalai R. (2009), Drug design ingfor ring finger protein 110 involved in adenocarcinoma (human breast cancer) using Casuarinin extracted from *Terminalia arjuna*. *Indian Journal of Science and Technology,* 2(2):22-26.

Central Science Laboratory (2006), Plant Healthcare: Rusts [Fact Sheet]. Retrieved from www.csldiagnoshaustics.co.uk

Chandrashekara K. T., Prakash B. M., Mahesha K. S. and Rajasekhar N. (2012), Antifungal activity of plant extracts against leaf rust disease of mulberry. *Journal of Sericulture Technology,* 3:60-63.

Cowan M. M. (1999), Plant products as antimicrobial agents. *Clinical Microbiology Reviews*, 12:564-582.

Das K., Tiwari R. K. S. and. Shrivastava D. K. (2010), Techniques for evaluation of medicinal plant products as antimicrobial agent: Current methods and future trends. *Journal of Medicinal Plants Research*, 4:104-111.

Domijan A., Feraica M., Jurjevic Z., Ivil D. and Cvjetkovic B. (2005), Fumonisin B1, fumonisin B2, Zearalenone and ochratoxin, A contamination of maize in Croatia. *Food additives and contaminants,* 22:677-680.

Gangadevi V., Yogeswari S., Kamalraj S., Rani G and Muthumary J. (2008), The antibacterial activity of *Acalypha indica* L. *Indian journal of Science and Technology,* 1(6):1-5.

Gonzalez L. C., Gutierrez R. and Cascante F. (1977), Combate de enfermedades foliares en frijol (*Phaseolus vulgaris* L.) mediante el uso limitado de fungicidas. *Agronomia Costarricense,* 1(2):107-118.

Gupta S. K. and Shyam K. R. (1998), Control of powdery mildew and rust of pea by fungicide. *Indian Phytopathology,* 51(2):184-186.

Hammons R. O. (1977), Groundnut rust in the United States and the Caribbean. *PANS: pest articles and news summaries,* 3:300-304.

Janardhana G. R., Raveesha K. A. and Shetty H. S. (1998), Modified atmosphere storage to prevent mould-induced nutritional loss in maize. *Journal of Science Food and Agriculture,* 76: 573-578.

Kamble S. K. and Patil B. J. (2019), Efficacy of foliar spray applications of plant extracts against groundnut rust. *Current Research in Environmental & Applied Mycology* 9(1):113-121.

Khalil A. M. (2001), Phytotoxic properties in the aqueous extracts of some plants. *Pakistan Journal of Biological Sciences*, 4:392-394.

Kirk P. M., Cannon P. F., David J.C. and Stalpers J. A. (2001), Dictionary of the fungi, 9th ed, CABI, Wallingford, UK.Mohanan C. (2010), Rust Fungi of Kerala. Kerala, India: Kerala Forest Research Institute. pp: 148.

Koirala P., Kumar S., Yadar B. K. and Premarajan K. C. (2005), Occurrence of Aflatoxin in some of the food and feed in Nepal. *Indian Journal of Medical Sciences,* 59:331-336.

Lyon G. D, Relinski T. and Newton A. C. (1995), Novel disease control compounds: Potential to immunize Plants against infection. *Plant Pathology*, 44:407**-**427.

Manjappa K. (2015), Evaluation of antifungal properties of *Eupatorium* (*Chromolaena odorata* L.) plant extract against *Pyricularia oryzae* causing blast disease in rice crop. *Asian Journal of Pharmaceutical Science & Technology,* 5(2):79-81.

Marin S., Homedes V., Sanchis V., Ramos A. J. and Magan N. (1999), Impact of *Fusarium moniliforme* and *F. proliferatum* colonisation of maize on calorific losses and fumonisin production under different environmental conditions. *Journal of Stored Product Research,* 35:15-26.

Mayee C. D. (1982), Groundnut rust: a review, Indian Botanical Reporter. 1:75**-**83.

Mayee C. D. and Datar V. V. (1986), Phytopathometry. Tech Bulletin. 1 (Special Bull 3). Marathwada Agriculture University, Parbhani (Maharashtra). p. 66.

Mekonnen M., Manhile B. and Meng B. (2014), Screening of Botanical Extracts for the Control of Spearmint Leaf Rust in Greenhouse and Field Conditions, *World Journal of Agricultural Sciences,* 10(2):42**-**47.

Mendes, C. A. C., Mendes, G. E., Cipullo J. P. and Burdmann E. A. (2005), Acute intoxication due to ingestion of vegetables contaminated with aldicarb. *Clinical Toxicology*, 43(2):117**-**118.

Monda E. O., Asanga D. O., Okemo P. O., Ndegwa A. and Mariita M. R. (2009), Efficacy of selected plant extracts against bean rust disease (*Uromyces appendiculatus*) On

French Beans (*Phaseolus Vulgaris* L.) *Journal of Tropical Microbiology and Biotechnology,* 5:1.

Naz R., Bano A., Wilson N. L., Guest D. and Roberts T. H. (2014), Pathogenesis-related protein expression in the apoplast of wheat leaves protected against leaf rust following application of plant extracts. *Phytopathology*, 104(9):933-944.

Nutter F. W. and Shokes F. M. (1995), Management of Foliar Disease Caused by Fungi in: Peanut Health Management. H. A. Melouk and F. M. Shokes, eds., The American Phytopathological Society Press, St. Paul. MN. pp. 65-72.

Park J. W., Kim E. K. and Kim Y. B. (2004), Estimation of the daily exposure of Koreans to aflatoxin B1 through food consumption*. Food additives and contaminants,* 21:70-75.

Pawar D. S. (2013), Studies on antifungal activity of some plant extracts on spore germination in wheat and jowor rust. A Ph. D. thesis submitted to Shivaji University, Kolhapur. pp. 123.

Ritchie D. F. (1985), Strategies for the management of fungicide resistance in *Monilinia fructicola*, In: Proceedings of the Brown Rot of Stone Fruits Workshop (Burr T., ed.). Special Report 55, New York State Agricultural Experiment Station, Geneva. pp. 16-19.

Sasaki K., Iwai T., Hiraga S., Kuroda K., Seo S., Mitsuhara I., Miyasaka A., Iwano M., Ito H., Matsui H. and Ohashi Y. (2004), Ten rice peroxidases redundantly respond to multiple stresses including infection with rice blast fungus. *Plant Cell Physiology,* 45:1442-1452.

Satish S., Raghavendra M. P. and Paveesha K. A. (2009), Antifungal potentiality of some plant extracts against *Fusarium* sp. *Archieves of Phytopathology and Plant Protection*, 42:618-625.

Savile D. B. O. (1976), Evolution of the rust fungi (Uredinales) as reflected by their ecological problems. *Evolutionary Biology*, 9:137-207.

Singh R. A, De R. K and Chaudhary R. G. (2004), Influence of spray time of Mancozeb on Pea rust by *Uromyces vicae-fabae. Indian Journal of Agricultural science,* 74(9):502-504.

Smith D. H. and Littrell R. H. (1980), Management of peanut foliar diseases with fungicides. *Plant Disease,* 64:356-361.

Srivastava L. S. (1999), Efficacy of fungitoxicants in managing rice bean rust in Sikkim. *Journal of Hill Research,* 12(1):86-87.

Subramani D., Rajanaika K., Chinnaswamy K. K., Singh S., Puthenveetil V. K., Bhat S. S. and Jayarama (2012), Comparative efficacy of plant products on the spore germination and disease incidence of coffee leaf rust pathogen. *Acta Biologica Indica,* 1(1):69-75.

Wheeler B. E. J. (1969), An Introduction to Plant Diseases. John Wiley and sons Ltd. London, pp. 301.

Yasser S. M., Abdalla M. E., Atef A. S., El-Sawy M. M., Draz I. S., Ahmed W. Y. (2016), Efficacy of plant extracts in controlling wheat leaf rust disease caused by *Puccinia triticina*, *Egyptian Journal of Basic and Applied Sciences,* doi: 10.1016/j.ejbas.2016.09.002.