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# A Review on New Prospects and Agitates for Passable Control of *Macrophomina Phaseolina* Disease on Mungbean (*Vigna Radiata* L. Wilzeck)

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***Abstract*: Mungbean (Vigna radiataL.Wilzeck) is most important legume crop in world. The genus *Vigna* belongs to subfamily Papilinoidae and family Leguminoseae. It is mostly grown in Asian region but its cultivation is spread to Africa and Americas in recent times. But *Vigna radiata* is consumed in sprout and dry seed form because of its high protein content. Mungbean is generally grown in arid and semiarid regions due to its rapid growth and early maturing characteristics and ability to restore the soil fertility to make it valuable crop. The main characteristic of mungbean is reducing fertilizer and providing lack of supply nitrogen fertilizer to the agriculture field improving soil structure and providing plant protein but the time of flowering and maturity is shortened under stress compared to well in water conditions. Irregular annual rainfall and lack of source management cause severe decrease in crop yield. *Macrophomina phaseolina* is a wide host range and responsible for causing losses on cultivated crop or wild crop yield. It causes decrease in stem height, root length and head weight. This pathogen infects all plant parts such as seed infection ranges from 2-16% causing 11% decrease in grain yield and 15% reduction in protein content due to this pathogen. There are number of strategies are used to reduce the number of sclerotia in soil and minimize the contact of inoculum host. Soil moisture content, Tillage, Rotation is also responsible to reduce the population of *Macrophomina phaseolina*. Various measures are used to control the infection of Charcoal rot disease. we use chemical fumigates, amendments with bio fertilizers by using biological control anatagonists, Fungicides Chemicals are also used to control the infection of fungus. Bio control approach is also help to manage the pathogen in crop plants. In Bio control measure we use medicinal plant extracts helps to reduce the growth of *Macrophomina phaseolina*. The recent studies shows that crude extract and purified isolated compounds from plants can be used to control *Macrophomina phaseolina* in our crops by different measures.**

***Keywords*: Vigna radiata, Ocimum sanctumL, Calotropis proceraL, Astragalous tribuloides Delile.**

## 1. Introduction

Mungbean is an important pulse crop in our country. In India, mungbean cultivated in three different seasons. viz Kharif, Rabi and Summer. It is also grown in rainfed condition during kharif and residual moisture during rabi in eastern and southern part of India. The seed rate of mungbean is 10-15 kg/ha in kharif season 20-3 kg/ha seed rate in spring season crop (Chadha, 2010). Mungbean is rich source in variety of Polyphenolic compounds, including simple phenols, Flavonoids and Tannins that is considered as natural antioxidants(Prior and Gu,2005; Sanos Bulega and Scalbert,2000; Amarowicz etal.,2004 and Troszunska and Cisa, 2002).But Biotic factors are responsible for losses of pulse crop up to 44%-60% (Deshkar etal.,1974; Bashir and Malik,1988). *Macrophomina phaseolina* causing charcoal rot in mungbean to reduce the crop yield especially in arid regions (Charles 1978; Hoes., 1985).

*Macrophomina phaseolina* attacks on all parts of plant like root, stem, branches, petiole, leaves, pods and seeds. Moreover, seed infection of *Macrophomina phaseolina* ranges from2.2-15.7% which causes 10.8% reduction in grain yield and 12.3% reduction in protein content in urdbean (Kaushik et al., 1987). In mature plants, *Macrophomina phaseolina* causes red to brown lesions on roots and stems. It produces dark mycelia and black microscelerotia and plants became defoliate and wilted (Abawl and Pastor- Corrales, 1990). *Macrophomina phaseolina* is a heat tolerant pathogen in temperature range 60-65°C (Bega and Smith, 1962: Milhail and Acron, 1984).

## 2. Economic Impact of Mungbean *Macrophomina phaseolina* Fungal Disease

Charcoal rot disease is caused by a common soil- borne fungus known at its imperfect stage as *Macrophomina phaseolina* (Whittaker.,1969), the perfect stage being *Sclerotium bataticulum* Taub.(Butl.). This fungus belongs to Botryosphaeriaceae family. It infects nearly 500 plant species in 75 families with wide geographic distribution (Dhingra and Sinclair, 1978; Bouhot, 1967, 1968 and Gray et. al, 1990; Crous etal, 2006). *Macrophomina phaseolina* causes seedling blight, stem rot and pod rot (Sinclair,1982).It has very wide distribution covering most of the tropics, subtropics and temperate zones(Singh.,1953; Kumar et al1969, Philip et. al.,1969; Dhingra and Sinclair,1977; Smith and Carvil,1977; Songa,1995). This pathogen affects those crops, where high

temperature and water stress during the growing season (Cook et al., 1973; Meyer et al., 1974; Short et al., 1980).

*A. Loss in Yield caused by Macrophomina phaseolina*

Yield losses caused by *Macrophomina phaseolina* results from plant death or lodging. Lodging occurs at maturity stage that weak the stem and microsclerotia form in vascular tissues (Edmunds, 1964; Odvody and Duke, 1979). 60% yield losses due to charcoal rot (Steven et al., 1987). Annual losses of mungbean is 330-50% due to the infection of Charcoal rot (Ramazami et. al., 2007;Senthil Umar etal.,2009).

The low productivity and poor quality of mungbean are attributed to several biotic and abiotic constraints of which diseases caused by fungi (Khan and Khan, 2001). Seed borne disease of many crops, inflicting upto 100% yield losses in mungbean under dry and hot conditions. *Macrophomina phaseolina* show necrotic lesions on mungbean leaves (Bouhot, 1967).

There was 9.38% losses in plant height, 26.32 % loss in number of leaves per plant, 30% loss in number of pod per plant and 40% loss in pod weight per plant (Tiwari and Kotasthane,1986) reported 10.8% yield loss due to leaf and pod infection by *Macrophomina phaseolina* in mungbean(Kaushik etal.,1987).

## 3. Prospects and Passable Disease Management

There are number of strategies are used to reduce the number of sclerotia in soil and minimize the contact of inoculum host. Soil moisture content is responsible for heat treatment and fumigation is responsible to reduce the population of *Macrophomina phaseolina* upto 42% (Lodha et al., 2003; Dhingra and Sinclair, 1975; Watanable et al., 1970).

*A. Physical Practices*

Tillage is an essential practice that affects the inoculum potential of soil borne pathogen. Tillage reduces the stratification of organic residue on the surface that can influence soil temperature, moisture (Champbell and VanderGaag, 1993).These changes in physical and biological affects disease incidence and severity of *Macrophomina phaseolina*. If the pathogen requires high inoculum density to infect plants and they increased dispersal of soil profile to reduce disease severity. However, a low inoculum density is sufficient for infection and dispersion may aggravate incidence and severity (Olanaya and Champbell, 1988).

Irrigation in cropping season reduces disease infection (Kending et al., 2000).The type of irrigation can affect the charcoal rot disease. The density of soil sclerotia and number of diseased plants was higher in drip irrigated lots than in furrow irrigated plots (Nischwitz et al., 2004).The host plant is destroyed by fungal toxins such as phaseolinone and vascular obstruction by mycelium (Bhattacharya et al., 1994).Since the pathogen is soil borne with high saprophytic ability, effective strategies for disease control are not available.

*B. Chemical Practices*

Chemical control is good choice to control the fungal disease. This practice provide quick, effective as precautionary measure (Sharma, 1996; Kata, 2000). Thiram and Carbendazin have been used widely for controlling Charcoal rot (Gaikwad, 2002). Tetramethyl Thiuram disulfide (Vitavax-200) is effective for *Macrophomina phaseolina (*Patil and Kamble,2011).Out of the chemical fungicides used several pose to concern serious acquired resistance like chlonitrobenzene, Bavistin,Vitavax, Brassicola, Allisan, Topsin M (thiophanatemethyl) and Rhizolex (tolclofos-methyl)(Pande et al,1989;Chattopadhyay et al.,1990).Herbal oils are generally used to inhibit the mycelia growth of pathogen. These oils are Panoram, Mancozeb, Calixin, Liromenzeb, Antracol and Rubigon.

Among these chemical fungicides Bavistin, Captan, Thiram, Indofil M-45, Vitavax or Raxil. Bavistin 50 WP (Carbendaziol) was most effective against *Macrophomina phaseolina(*Rathore and Rathore,1999).Application of Bavistin and Captan is more effective fungicide to reduce the mycelial growth of *Macrophomina phaseolina* and gave complete inhibition of mycelial growth at 1000ppm concentration. Calixin and Rubigon reduced mycelial growth significantly but decrease in sclerotial production and germination was lower as compared to Panoram. Bavistin, Calixin, Antracol and Rubigon were equally effective in reducing mycelial growth. Bavistin belongs to the benzimidazol group of fungicides and gives similar mode of action (Vyas, 1984).The active ingredients are Fluquinconazole, Metalaxyl,Thiram and Tolyfluanid showed IC50 is higher than pyraclostrobin is moderatly sensitive. Fluquinconazole, Metalaxyl, Thiram and Tolyfluanid are non toxic ingredients to *Macrophomina phaseolina* (Edginton etal., 1971).

Carbendazamin was found to be highly effective against *Macrophomina phaseolina* and enhanced the growth of plant to a maximum extent. Carbendazamin has great effectiveness against root rot fungus (Dubey and Singh. 2013).Carbendazamin induced systemic resistance nature in mungbean plants making them less susceptible to *Macrophomina phaseolina* due to its unique mode of action as its inhibits mitosis during cell division by interfering in spindle formation through inhibiting β-tubulin assembly to prevents multiplication of the pathogen (Pall et al., 1980; Khan and Gupta, 1998).

Non systemic fungicides viz., Mancozeb and Thiram inhibited the growth of root rot fungus followed by Captan (Lokesha, 2003). Infection of mungbean by *Macrophomina phaseolina* exhibited significant reduction in root nodulation and corresponding nodular dry weight. Rhizobia invade and form nodules on the lateral roots.Roots of infection with *Macrophomina phaseolina* cause rotting, decay, emergence of lateral roots and nodule formation is suppressed (Khan et.,al 2001).It is reported that there is a significant reduction in root nodule formation on infection by root rot fungus(Muthomi et al., 2007).So, the treatment of fungicides in the order of effectiveness of the tested fungicides were found as Carbendazamin >Captan> Thiram> Vitavax> Mancozeb.

*C. Biological practices*

The Biological approach using PGPR strain helps to develop the strategy for managing pathogens in crop plant. The

utilization of plant own defense mechanism is systematically activated on exposure of plants to PGPR strains (Baker et al., 1997).This phenomenon is called Induced Systemic Resistance(ISR)(Tuzun and Kuc,1991).

Biological control is promoting plant growth resistance of plant pathogens by rhizospheric microorganisms. The microorganisms involve directly or indirectly effect on the pathogens. The filamentous fungus is wide spread in nature, with high population densities in soil and plant liters. They are saprophytic in nature and produce large amount of conidia with long lifetime (Manczinger etal., 2002). The uses of microbial antagonist and biological control is considered more or less successful (Gupta et al.,2002;Deshwal et al.,2003 and Adeunle et al.,2006).Biological control is an effective mean to control plant disease; cheaper, in cost and safer for application and user friendly (Abd-elMoitl.,1998).

Neem, Cotton, groundnut cakes are also reported to reduce the inoculum level of *Macrophomina phaseolina* (Desai, 1997; Hundekar, 1998). Biological control using anatagonist like *Trichoderma virdae*, *Aspergillus flavus*, *Bacillus subtilis*, *Streptococcus sp.* is successful to a certain extent (Ghaffar,1971;Adhilakshmi et al.,2014).

Medicinal plant extracts are a viable alternative against many fungal phyto-pathogens (Vogt et.al. 2015). Neem, cotton, groundnut and sunflower cakes are reduce the inoculum level of *Macrophomina phaseolina* (Desai et al., 1997; Hundekar et al., 1998).*Calotropis procera* extracts reported to be active against charcoal rot in Vitro condition(Jabeen et.,al 2013). Plant based bioactive compounds against phytopathogenic fungi and methanol extraction is more effective than other extraction solvents. *O. gratissium* leaf extracts was more effective than *A. melegueta* (Yazdani et al., 2011).

Bioactivity of extract obtained from leaves of medicinal plant extract on growth of *Macrophomina phaseolina*. The crude leaf extract of few medicinal plants can be used as fungicides which are ecofriendly and does not show adverse effect on the fertility of soil as well as quality of seeds. The leaf extracts of neem, garlic, tulsi and onion have some fungicidal properties that inhibit the growth of the fungi(Singh et al.,2014).The crude extracts and purified isolated compounds from plants can be used as natural fungicides for the management of plant diseases(Jabeen and Javaid,2010;Kanwal et al.,2010 and Riaz et al.,2010).

### *D. Hypersensitivity response*

Hypersensitivity response is used by plants to prevent the spread of infection by microbial pathogen. It is characterized by the rapid host death cells in local region that surrounded by infection .These cells associated with defense mediated by 'Resistance genes' (Bryant and Tracy. 2008).

Hypersensitivity response involves, where genes generates an oxidative burst by producing reactive oxygen species (ROS) such as superoxide anions, Hydrogen peroxide, Hydroxyl radicals and nitrous oxide species. These cell compounds affect a cellular membrane to cause lipid damage (Mathews Ben., 2007).These compounds create a barrier to inhibit the spread of the infection (Pontier et.,al 1998).Several enzymes are involved as mediators of hypersensitive response. It involves such as Phenolics, Phytoalexins and Pathogenesis related proteins (PRP) Proteins.

## 4. Enzymes help in Plant Defense

### *A. Peroxidase*

Peroxidase play important role in biochemical plant defense against microbial pathogen. It involves cell wall lignifications, substrate oxidation, photosynthesis, respiration and growth regulations (Srivastava., 1982).It play important role in plant pathogen interaction and catalyzes the oxidation of hydroxyl-cinnamyl alcohol into free radical (Gross.,1980).Peroxidase is lined to lignification and generation of hydrogen peroxidase at later stage of infection to inhibit pathogen directly or generating other free radicals with antimicrobial effects to restrict the development of Phytopathogenic bacteria (Silvia et al.,2004).Peroxidase is important in PR Proteins (Vanloon etal.,1994).These proteins express peroxidase actively during host pathogen interaction(Yung et al.,1995;Saikia et al., 2004).

### *B. Polyphenol oxidase*

Polyphenol oxidase is a monophenol oxygenase. It is (3, 4 L-dihydroxylphenyl alanine: Oxygen oxido reductase).It is a compound that contains four atoms of copper per molecule and binding sites for two aromatic compounds and oxygen (Worthington,2011). This enzyme catalyzes the o-hydroxylation of monophenol molecules in which benzene ring contains a single hydroxyl substituent to o-diphenols. It play important role in plant defense via the oxidation of endogenous phenolic compounds into 0-quinones they are highly toxic when they invading into pathogens and pests and they increase their fungal infection (Mohammadi and Kazemi., 2002). Secondary reactions is responsible for wounding and responses to pathogens (Thipyapong et al, 2004).The accumulation of proline occur in response to biotic stresses such as pathogen infection (Slama etal., 2006).

### *C. Pathogenesis related Proteins*

Pathogenesis related Proteins are the proteins that are produced in plants and attack on pathogen (Loon. 1985).Infected genes produce PR proteins. Some of these proteins are antimicrobial and antifungal because of their attacking king molecule in the cell wall of fungus. Infection also stimulate the cross linking of molecules in the cell wall and the deposition of lignin and response a local barricade that slow the spread of pathogen or other parts of plant (Campbell and Reece.,2005).These proteins lead to increase the resistance of whole plant against a pathogenic attack(Adrienne and Barbara,2006).There is large number of small, basic cysteine rich antimicrobial proteins that is produced by many organisms in throughout all plant kingdom(Leiter et al.,2000).Antifungal Pathogenesis related proteins have potential use of food and seed preservative agents to phytopathogenic fungi(Dempsey et al.,1998).There are many antifungal protein genes that seems to be more effective than expression of single gene (Bormann et al.,1999).

Pathogenesis related proteins have antifungal activity. It has the ability to hydrolyze the fungal cell wall component. They hydrolyze the β-1, 3 glucanases and chitinases to inhibit the growth of fungal pathogens (Loon, 1985; Campbell and Reece, 2005). These proteins help in releasing the elicitor of oligosaccharides from the cell wall of pathogens and inducing the various plants defense mechanisms. Pathogenesis related Proteins 3 is a group of endochitinase that hydrolyzes β-1, 4 linkages between N-acetylgluocosamines of chitin and release oligosaccharides from the cellwalls of many fungi (Boller,1993).

Class 1 of Pathogenesis related proteins of chitinase. It has cysteine rich domain and has 10-15 fold of higher chitinase activity and has antifungal activity in vitro studies of *Macrophomina phaseolina* (Broglie et al., 1991).

Pathogenesis related proteins 4 are acidic protein that is bind with a chitin molecule and namely as tetrameric β-(1, 4) oligosaccharide of AN-Acetyl glucosaamine (Svenson and Svendsen.,1992) PR-4 protein is induced by pathogen attack as well as $O_3$ in Arabidopsis plants (Rao.,2002).These protein has two groups. They have small antifungal Hevein and Win protein from rubber. Hevein proteins is structurally similar with wheat germ agglutins, lectins and win proteins that were identified in potato PR-4 Proteins were recently found in floral nectar from fungal infestation (Gonzalez-Teuber et al., 2009). PR-12 Proteins is a type of thionins proteins. These proteins are detected after the localized fungal or bacterial infection (Pennecks etal.,1996; Thomma et al.,2002).PR-13 are thionins proteins interact with negatively charged membrane phospholipid and cause membrane disruption by forming pores. These proteins exhibit the toxicity for plant pathogen and divided into two major group β and γ –thionins.

PR-14 Proteins are lipid transfer proteins and they are basic in nature. They participate in cutin formation in vivo condition and help in sumbiosis and adaptation of plants to various environmental conditions. These proteins are antibiotic activity against bacterial and fungal pathogens.PR-15 Proteins are glycoproteins in nature and responsible for generation of reactive oxygen species after pathogen infection (Xvet etal., 2003).

## 5. Genetic Basis of Fungal Resistance

The immune system of plant pathogens bears the presence of highly effective system of defense response against pathogen invasion and disease. One system is based on disease resistance genes to allow detecting plant pathogen infection and mounting effective defense response. These genes were identified in 20 th century (Ellis and Jones, 1998; Ellis et al., 2000). Pathogens deploy three main strategies to attack plants: Necrotrophs, Biotrophy or Hemibiotrophy. Necrotrophs first kill host cells and then metabolize their content. Cell death is induced by toxins and enzymes targeted to specific substrates (Walton, 1996). Such as Phytium, and Botrytis. These are fungal nectrotrops.

Biotrophs and Hemibiotrophic pathogens invade the living cells to favour their growth and reproduction. Senescing of leaves in plants surrounds the biotropic infection sites of fungal rusts and mildews that attest to host cells such as Phytopathogenen and Colletotrichum to kill the surroundings host cell during later stage of infection.

Genetic basis of host pathogen interaction has three views:- the genes foe gene model, the matching –allele model and the quantitative view of resistance. In gene for gene model refers to a specific genetic interaction between a host and pathogen. It states R gene in the host and a virulence gene (Avr gene).R gene is host recognize Avr gene in the pathogen in host gene (Flor., 1956). There is genetic interaction between host and pathogens to assessing the gene for gene view.

In other view termed as the matching allele to explain the genetics underlying the host resistance (Frank. 1993). It predicts the parasites that attack on the same number of hosts (Parker. 1996).

Quantitative resistance does not require the presence of specific genes and combined those genes to determine the effective genes to prevent the pathogens they are affective by environmental conditions such as temperature and nutrients (Smith and Black, 1987; Field et al., 2002).

## 6. Conclusions and future prospects

Food legumes are a vital source of dietary proteins in developing world. The crop plants are frequently subjected to biotic and abiotic stresses. The present review identified that root rot caused by soil-borne pathogens to compact mungbean production. The phenolic compounds play the role of phytoanticipins in plants (VanEtten et al., 1994).The phenolic acids exhibit strong antibacterial property against Gram positive bacteria and partial inhibition of Gram negative bacteria. The Gram negative bacteria differ from Gram positive bacteria having a thick liposaccharide coated cellwall which is not permeable to polar phenolic acids to effect low mortality rates. The antifungal activity of polyphenolic compounds is thought to be the formation of multinucleate stage by the breakage of intersepta in the mycelium and the cell surface damage by pilferage (Bais et al., 2002).

Pharmacological, Pharmaceutical botany, medical and clinical microbiology, Phytopathology and food processing are some fields in which phenolic compounds can be applied. Several antimicrobial drugs are available in market, but antimycotic drugs have several limitations such as low potency, poor solubility and drug toxicity (Bisignano et al., 1999).Fungicides resistance management strategies (such as Physical, Chemical, Biological, Genetical and Enzymatical are different groups of fungicides) should be deployed and help to reduce the risk of developing fungicides. Chemical and Biological prospects used for the control of *Macrophomina phaseolina*. Peroxidase are the enzymes that are most directly involved in lignin biosynthesis that are enzymatically dehydrogenated in the cell wall to phenoxy radicals. These radicals polymerize spontaneously, yielding a complex net of cross linking among monolignols, proteins and polysaccharides (Liyama et al.,1994).Peroxidase implicate the cross linking reactions (Polle et al.,1994).

Recent studies have indicated that phenol-oxidizing enzymes may participate in response to the defence reaction and

hypersensitivity in inducing resistance of plants to biotic and abiotic stress (Jouili and El-ferjani, 2003; Jung, 2004). This review has provided an overview of the physiological, biochemical and molecular response of *Vigna* under *Macrophomina phaseolina* infection and shed light on the putative mechanisms involved in increasing tolerance to such biotic stress factors. Targeted functional studies of important genes are molecular pathways may help to unravel their biological function during the course of producing resistance plants.

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