Mini Review Article

ALTERNARIA BLIGHT AS SEED BORNE CHRONIC DISEASE OF RAPESEED AND MUSTARD AND ITS INTEGRATED DISEASE MANAGEMENT

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ABSTRACT

India is the fourth largest oilseed producing country in the world, next to USA, China and Brazil. With its rich agro-ecological diversity, India is ideally suited for growing all the major annual oilseed crops. Rapeseed- mustard is a group of crops which contributes 32 percent of the total oilseed production in India, and it is the second largest indigenous oilseed crop. India holds a premier position in rapeseed-mustard economy of the world with 2nd and 3rd rank in area and production, respectively. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop. Despite considerable increase in the productivity and production of the crop under research experiments, a wide gap is found to exist between the potential yield and the yield realized at the farmer's field, which is largely because of a number of biotic and abiotic stresses to which the rapeseed-mustard crop is exposed. Among the biotic stresses, Alternaria blight disease caused by *Alternaria* spp. has been reported from all the continents of the world and is one of the important seed borne (externally and/or internally) disease of the crops in India causing up to 70% yield losses. A typical symptom includes formation of spots on leaves, stem and siliquae. Leaf wetness duration at 23-25^{0}C, high relative humidity (100%) increased infection and spread of the disease rapidly. The pathogen may survives in plant debris up to 12 weeks and as internal mycelium up to 12 years. Management practices of seed borne pathogens, which involves individual or combined application of cultural, physical, biological and chemical practices resulting high crop yield.

INTRODUCTION

India is known for its rich agro-ecological diversity, and is ideally suited for growing all the major annual oilseed crops and currently it occupies 14% of the area under major oilseed crops. Thus it holds significant share in the whole world (Statistics, 2015). Among the nine oilseed crops grown in the country, seven are of edible oils (soybean, groundnut, rapeseed-mustard, sunflower, sesame, safflower and niger) and two are of non-edible oils (castor and linseed). India is the fifth largest vegetable oil economy in the world, next only to USA, China, Brazil and Argentina, and has an annual turnover of about Rs 80000 crore. Total oilseed production in worldwide basis is 463.3 million tones during 2012-13 as shown in table 1. Rapeseed (*Brassica campestris*) and mustard (*B. juncea*) are the major rabi oilseed crops of the country and holds a premier position in economy of the world with 2nd and 3rd rank in production and area respectively. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop. Rapeseed- mustard is a group of crops which contributes 32 percent of the total oilseed production in India, and it is the second largest indigenous oilseed crop. Of 75.55 m tones of estimated rapeseed- mustard produced over 30.51 m ha in the world, India produces 7.36 m tones from 6.18m ha with 1190 kg/ha productivity (GOI, 2009), thus playing a pivotal role in agricultural economy of the country. Despite considerable increase in the productivity and production of the crop under research experiments, a wide gap is found to exist between the potential yield and the yield realized at the farmer's field, which is largely because of a number of biotic and abiotic stresses to which the rapeseed-mustard crop is exposed. Among the biotic stresses, Alternaria blight disease caused by *Alternaria* spp. has been reported from all the continents of the world and is one among the important diseases of the crop in India causing up to 47% yield losses (Kolte, 1985). Saharan, 1992; Kolte, 2002 reported that *Alternaria* blight sometimes causes

more severe losses (up to 70%) in rapeseed (*Brassica campestris*). The blight also reduces seed size and impairs seed color and oil content (Kaushik *et al*., 1984). The pathogen can affect all the stages of growth as well as seeds.

Table 1. World production of major oilseeds

Crop	Production (million tons)		
	2010/11	2011/12	2012/13
Soybean	265.2	239.8	268.6
Rapeseed	60.8	61.5	60.1
Cotton seed	43.7	46.5	43.3
Groundnuts	36.9	36.6	37.0
Sunflower	33.1	38.8	35.2
Others	17.5	18.1	18.9
Total	457.2	441.4	463.3

(Source: FAO - Trade and Markets Division, 2012)

Table 2: Morphological structure of *Alternaria* spp. causing leaf blight of Rapeseed and Mustard

Fungal structure	*A. brassicae*	*A. brassicicola*	*A. raphani*
Mycelium	Septate, brownish grey	Septate, olive grey to greyish black	Cottony whitish to greenish grey or dark olive
Conidiophore	Dark, septate, arise in fascicles, 14-74µ x 4-8µ	Olivaceous, septate , branched, 35-45µ x 5-8µ	Septate, olive-brown, single or branched, 29-160µ x 4-8µ
Conidia	Brownish black, obclavate, muriform, produced singly or in chains or 2-3	Dark cylindrica l to oblong, muriform, produced in chains of 8-10 spores	Olive- brown to dark, obclavate, muriform, more-or-less pinpointed at each end, appea r singly or in chains of up to 6 spores
Spore body (µ)	96-114 x 17-24	45-55 x 11-16	45-58 x 13-21
Spore beak length (µ)	45-65	none	1-25
Transverse septa tion	10-11	5-8	6-9
Longitudinal septation	0-6	0-4	3-6
Infection	Penetrates leaf only through stomata	Penetrates leaf directly or through stomata	Direct penetration

(Source: Meena *et al*., 2010)

1. Symptoms

A. brassicae can affect host species at all stages of growth, including seed. Symptoms of the disease are characterized by formation of spots on leaves, stem and siliquae. *A.brassicae* and *A. brassicicola* can affect host species at all stages of growth, including seed (Fig 1.). On seedlings, symptoms include dark stem lesions immediately after germination that can result in damping-off, or stunted seedlings. *A. raphani* produces black stripes or dark brown, sharp-edged lesions on the hypocotyls of the seedling. It grows in the vascular system and rapidly infects the entire seedling (Valkonen and Koponen, 1990). Spots produced by *A. brassicae* appear to be usually grey in colour compared with black sooty velvety spots produced by *A. brassicicola*. Spots produced by *A. raphani* show distinct yellow halos around them. However, the symptoms may vary with the host and environment. Symptoms are first visible on lower leaves with appearance of black points, which later enlarge to develop into prominent, round, concentric spots of various sizes. With progress, the disease appears on middle and upper leaves with smaller sized spots, when defoliation of lower leaves occurs. Later, round black conspicuous spots appear on siliquae and stem. These spots may coalesce leading to complete blackening of siliquae or weakening of the stem with formation of elongated lesions. Rotting of the seed may be seen just beneath the black spot on siliqua of toria and yellow or brown sarson. Spots on mustard siliqua are brownish black with a distinct grey centre. When older plants become infected, symptoms often occur on the older leaves, since they are closer to the soil and are more readily infected as a consequence of rain splash or windblown rain. Late infection or infection of older leaves does not characteristically reduce yields and can be controlled through intensive removal of infected leaves (Chupp and Sherf, 1960). Fruit bearing branches and pods show dark or blackened spots that result in yield loss due to premature pod ripening and shedding of the seed. The infection of *Alternaria* blight on leaves and silique reduces the photosynthetic area drastically. The phase of infection on silique adversely affects the

normal seed development, seed weight, colour of seed and percent oil content in seed and the quality of seed oil.

2. Etiology

2.1. The causal organism: Neergaard (1945) proposed three sections for the genus based upon the formation of conidia in long chains (Longicatenatae), short chains (Brevicatenatae), or singly (Noncatenatae). According to Ellis (1971), it contains 44 species. *Alternaria* species (*A. brassiace*, *A. brassicicola* and *A. alternata*) are either parasites on living plants or saprophytes on organic substrate. The morphological features of these three *Alternaria* sp. varied as shown in Table 2. The host range of pathogenic *Alternaria* is very broad. It is easy to recognize *Alternaria* sp. by the morphology of their large conidia. They are catenate, formed in chains or solitary, typically ovoid to obclavate, often beaked, pale brown to brown, multi-celled and muriform (Ellis, 1971). In favourable conditions, mature rapeseed-mustard seeds carrying the light grey colormycelium of the pathogen externally and/or internally (Maringoni, 2005).

2.2. Role of seed for disease perpetuation: The pathogen survives in the infected seeds which are considered as the main source of the disease (Richardson, 1996). *A. brassicae* is associated with the seed of mustard and mostly confined within the seed coat and sometimes within seed surface. All the three species of Alternaria mentioned above are known to survive through seed infection or as contamination on the seed surface (Maude and Humpherson Jones (1980).

3. Epidemiology

Weather conditions like humidity, temperature and frequent rainfall played key role for the epidemics (Shrestha *et al*., 2005 and Thind *et al*., 2008). A report was found by Sangeetha and Siddaramaiah (2007) that proved that maximum temperature is positively correlated with disease index for almost all diseases of *Alternaria* blight. Maximum temperature from 26-29ºC and average relative humidity of more than 65% favored the development of all the three disease. Kadian and Saharan (1984) reported that 25º C as the optimum temperature for spore germination of *Alternaria brassicae* while France, Louvet (1958) observed severe development of *A. brassicae* at the temperature range of 15-22ºC and relative humidity of 80 per cent for a period of 36hr and under condition of stormy and high wind velocity.

4. Integrated Disease Management strategies (IDM)

4.1. Cultural practices:

1. Meena *et al*. (2002) described that early sowing of properly stored, clean, and certified seed immediately after deep ploughing is very fruitful. Clean cultivation with timely weeding and maintenance of optimum plant population helps to reduce the disease to many folds. Care should be taken to avoid irrigation flowering and pod formation stages helps to manage the disease properly.
2. Potassium must be applied as basal in soil that helps in checking *Alternaria* blight disease in mustard (Sharma and Kolte, 1994).
3. In the Brassica gene bank nocomplete resistant variety has been available against *Alternaria* blight. As such population improvement programme by means of the selected lines as base population would genetically enhance the level of resistance. The breeding programmes with multilocational trials can effectively enhance pathogenic variability besides efforts on biocontrol of the disease and epidemiological studies at different locations.
4. Variability studies at pathogenic and genetic level in *A. brassicae* could allow easier improvement of disease resistant material.
5. Dasgupta *et al*. (1991) depicted that increase disease intensity and loss in yield is due to delay in sowing of mustard crop. In India, early sowing of toria (*B. rapa*) in September usually escapes *Alternaria* infection.
6. All the seeds should be cleaned thoroughly before to avoid initial inoculums of the disease.

4.2. Physical treatment: Physical treatments employs mostly heat treatments of seeds (Singh and Panday, 2012) that inactivates or kills many pathogens at a time and the most common is the hot water treatment, being a long-known technique consisting of the immersion of seeds in agitated water at a predetermined temperature and time. Besides that, hot air treatment can also be applied although less effective then hot water treatment. Electromagnetic radiations (UV light, X ray, has been found effective in treating *Alternaria* spp present in the seeds by disrupting sporulations.

4.3.Biocontrol agents: The most famous aphorism of biocontrol was given by Cook in 1985, who said that biocontrol is one of the viable, ecofriendly propositions available in modern agriculture which can significantly minimize the disease incidence. Pretreatment with *Streptomyces rochei* and *S. hygroscopicus* showed marked reduction of leaf blight intensity caused by *Alternaria brassicae* and *A. brassicicola* on brown sarson (Jayant and Sinha, 1981). Meena *et al*. (2010) found that there are certain biological agents responsible for controlling Alternaria blight of Rapeseed and mustard. Spray of soil isolates of *Trichoderma viride* at 45 and 75 days after sowing could manage Alternaria blight of Indian mustard (*Brassica juncea*) as effectively as mancozeb (Meena *et al*., 2004), which have been confirmed later in multilocation trials (AICRP-RM, 2007).

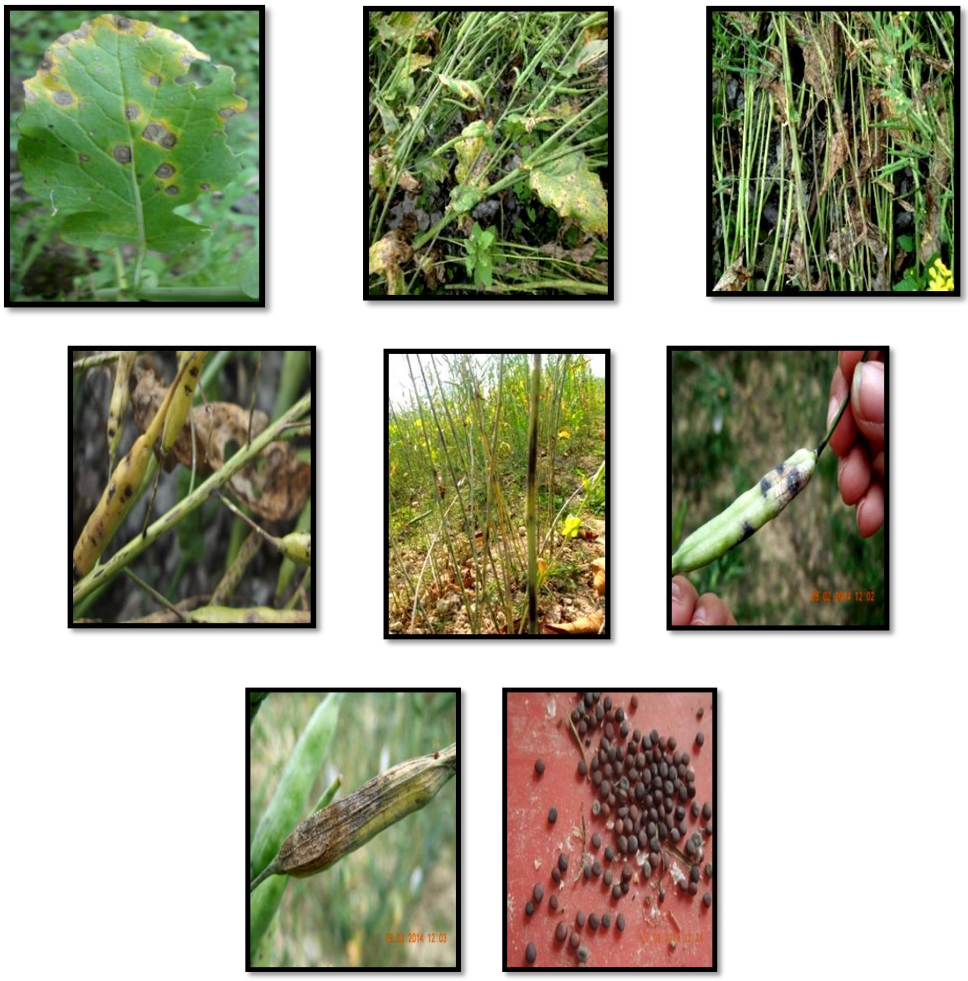

Fig. 1. Diagnostics symptoms of *Alternaria* blight on leaves, stems, pods and seeds

4.4.Phyto-extracts/Botanicals: Bulb extract of *Allium sativum* has been reported to effectively manage *Alternaria* blight of Indian mustard (Meena *et al*., 2004; Patni and Kolte, 2006). Patni *et al*., (2005) reported that spray of five per cent concentration of Eucalyptus (*Eucalyptus globules*) and Ashok (*Polyanthia longifolia*) showed significantly reduce the *Alternaria* blight intensity and increased the yield and these results were at par with the spray of Mancozeb fungicide. Essential oil from the roots of radish (1:2500) inhibits *A. brassicae* (Nehrash, 1961).

4.5.Chemicals: Three systemic fungicides: Topsin-M (Thiophanate methyl, 70%WP), Ridomil MZ (Mancozeb, 64% + Metalaxyl, 8%WP), and Bavistin (Carbendazim, 50%WP) alone and in combination with four non-systemic fungicides Captaf (Captan, 50%WP), Indofil M-45 (Mancozeb, 75%WP), Indofil Z-78 (Zineb, 75%WP), and Thiram (Thiram, 75%WP) were evaluated both *in vitro* and *in vivo* for their effectiveness to manage Alternaria blight of rapeseed mustard caused by *Alternaria brassicae* (Khan *et al*. 2007)**.** Meena *et al*. (2011) reported that Mancozeb recorded the lowest mean severity (leaf: 33.1%; pod: 26.3%) of Alternaria blight with efficacy of garlic bulb extract alone (leaf = 34.4%; pod = 27.3%) or in combination with cow urine (leaf = 34.2%; pod = 28.6%) being statistically at par with the recommended chemical fungicide. Prasad and Narain (2007) reported that in severe conditions, spraying of Ridomil MZ @ 0.25 per cent or Mancozeb 0.25 per cent at 50 DAS following the spraying at 70 and 90 DAS is essential for managing the Alternaria blight on leaves and pods also.

4.6. Other control measures: Identification of signal molecules for induced resistance, development of bioformulations and disease forecasting techniques based on epidemiological findings will enable trigger newer strategies for environment-friendly disease management for providing safer *Alternaria* blight free production of Indian mustard (Meena *et al*., 2002)

CONCLUSIONS

In conclusion, *Alternaria* blight disease can be managed by rational using of bio-control agents, phytoextracts and fungicides etc either in individual or in combinations. Adopting cultural practices, development

of resistant varieties and combined application of IDM module is one of the most feasible and cost effective method. The use of bio-control agents/phyto-extracts can help to reduce use of fungicides and the environmental pollution.

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