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Alternaria Blight – A Serious Affliction of Rapeseed Mustard: A Review

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ABSTRACT: Rapeseed mustard is an important oilseed crop which dominates the world of oilseed after the soybean. Alternaria blight is the global headache of crop scientists, it can reduce yield by up to 70%. Currently, 50% of rapeseed yield is lost due to Alternaria blight around the globe. This disease is mainly caused by two fungal organisms- *Alternaria brassicae* and *Alternaria brassicicola*. These infections don't have reproductive stages and live as conidia or conidiospores on the remains of previous crops and vulnerable weeds. These are necrotrophic pathogens. The illness initially manifests as a black spot but subsequently grows larger and transforms into noticeable spherical patches with concentric rings. Many spots coalesce to form large patches showing blight and cause defoliation in severe cases, in the stem and pod areas circular to linear lesions may be found which elongate later. Small, discoloured, and shrivelled seeds are produced by infected pods. Reduced photosynthetic potential, early defoliation, flower bud abortion, premature ripening, siliquae dehiscence, seed shrivelling and reduced seed size, impairs seed colour, and reduced oil content are some of the factors that contribute to this disease's significant yield losses. In this review, we'll discuss the Alternaria blight taxonomy, economic importance, habitat, host range, pathogenicity, survival, symptoms and management. It would be helpful to find the impact of *Alternaria* disease on the mustard crops.

Keywords: Rapeseed-mustard, Alternaria blight, symptoms, pathogenicity, management, breeding.

INTRODUCTION

The rape seed mustard species of the member of brassica family holds the second-highest cultivated oilseed after soybean in India and third after *Glycine max* and *Elaeis guineensis Jacq.* The word "rape" comes from the Latin word" rapum" which means" turnip". The word' mustard', on the other hand, comes from the Latin word' museu 'or' must' which means' squeezed grape juice 'and' ardens' which means' hot and burning'. Historically, brassica is one of the earliest crops domesticated by humans. It is mentioned in several ancient writings and documents, possibly dating to around 5000BC being cultivated. There is evidence that it was cultivated in the Neolithicera. The mustard seed was discovered by Chanhudaro of the Harapan civilization. 2300-1750BC (Allchin 1969). The Aryans used Brassica seeds as spices and oils. However, the use of oil was more common among non-Aryansthan among Aryans. So forover 3,500 years, mustard played an important role in the Indian diet as a source of oil and vegetables. There are 8 species that come under rapeseed mustard given below Table 1.

Among the nine major oil crops, rapeseed mustard contributes about 24% of the share in the production and about 31% of the oil production in India. According to USDA during 2018-19 total mustard area was 36.6. Million hectares and total production of about 72.4 MT with 19.8q/ha. of productivity (MAFW Annual report 2018-19). India has a wide range of climatic variations and mustard is grown all over India from north to south and west to eastern part of India in diverse conditions such as soils, rainfall, temperature, pH, irrigated/rainfed etc.

A record amount of oilseeds are expected to be produced in the nation in 2021–2022, which is 2.55 million tonnes more than the 35.95 million tonnes produced in 2020–2021 (MAFW pib.gov.in). Additionally, the output of oilseeds for 2021–22 is 5.81 million tonnes higher than the average production of oilseeds. In the year 2019-20 total area under rapeseed mustard- was 68.563 lakh hectares from which total production was 91.236 Lakh tonnes with an average yield was 1331 kg/hectare. Major growing states are – Rajasthan, Haryana, Madhya Pradesh, Uttar Pradesh, West Bengal, Gujarat, Jharkhand, Assam, Bihar, and Punjab. Detailed data are available of major rapeseed mustard growing states with total area. Total production and average yield per hectare are in Table 2.

Introduction to Pathogen. The fungus that causes blight on Brassicaceae. Alternaria blight is caused by three species that are – *A. brassicae, A. brassicicola, A. raphanin.*

History. Historically, in 1817 genus *Alternaria* was described by Nees with the species *Alternaria tenuis.* The later year 1836 was renamed *A. alternata. Berkeley* also noticed as the fungal infection in the family

Brassicaceae as *Macrosporium brassica Berk*. Again it was renamed *A. brassicae* (Berk.) *Sacc* by Saccardo (1886). The Alternaria blight was originally noticed in India in 1901 on Sarson from Tirhoot (Butler, 1918), but the fungus was initially referred to as *Sporodochium brassica* Mass because it was believed to be a new discovery. Mason (1928) later observed *Alternaria* species for the first time from a herbarium specimen of sarson from Pusa (Bihar), India. Elliott (1917); Wiltshire (1933) conducted extensive research on the taxonomy of *Alternaria*. Later, the taxonomy, parasitism, and economic relevance of the *Alternaria* genus were thoroughly studied by Neergaard (1945). Joly (1959) documented the morphological variations found in *Alternaria* spp. He later split these into three divisions and provided a key for identifying the most prevalent species of the *Alternaria* genus (Joly, 1964). The Indian *Alternaria* species were thoroughly described by Subramanian (1971). Dematiaceous Hyphomycetes and more Dematiaceous Hyphomycetes define the morphological traits of several *Alternaria* spp (Ellis, 1976). Simmons (2007) published a collection of his lifetime's work in the book *Alternaria*: An Identification Manual.

Table 1: Rapeseed mustard species information.

Sr. No.	Common name	Botanical name	Chromosome number	Genome	Origin	Days to maturity (days)	Oil %	Reference
1.	Brown sarson	*Brassica campestris orsyn. B. rapa var. brown sarson*	2n = 20	CC	Eastern Afghanistan & adjoining parts of India & Pakistan	100–235	40 –45	Chauhan *et al.* (2011)
2.	Gobhi sarson	*Brassica napus*	2n =38	AACC	Native of Europe	145–180	37–45	Meena *et al.* (2016)
3.	Yellow sarson	*Brassica rapa var. yellow sarson*	2n = 20	AA	Eastern parts of India	120–155	41–47	Rakow *et al.* (2004)
4.	Taramira	*Eruca sativa*	2n = 22	EE	Native of Southern Europe & North America, introduced in India	140–150	34-38	Shinwari *et al.* (2013)
5.	Toria	*Brassica rapa var. toria*	2n = 20	AA	Ethiopia	70–100	36–44	Singh *et al.* (2017)
6.	Black mustard	*Brassica nigra*	2n = 16	BB	Central & South Europe	70–90	40-41	Katche *et al.* (2019)
7.	Indian mustard	*Brassica. juncea*	2n =36	AABB	Originated from North-eastern India & spread to Afghanistan via Punjab	105–160	38–42	Shekhawat *et al.* (2012)
8.	Karan rai	*Brassica carinata*	2n= 34	BBCC	Indian subcontinent	150–200	36–43	Seepaul *et al.* (2021)

Table 2: State wise production (Ministry of agriculture annual report 2021).

State	Area Lakh hactares	Production Lakh Tonnes	yield in Kg/ha
Rajasthan	30.763	42.024	1366
Haryana	6.413	11.499	1793
Madhya Pradesh	6.750	10.382	1538
Uttar Pradesh	7.593	9.567	1260
West Bengal	6.104	7.123	1167
Jharkhand	2.914	2.314	794
Assam	2.874	1.774	617
Bihar	0.752	0.893	1187
Punjab	0.310	0.459	1482

Taxonomy of *A. brassicae.*

Kingdom	Fungi
Division	*Ascomycota*
Class	*Dothideomycetes*
order	*Pleosporales*
Family	*Pleosporaceae*
Genus	*Alternaria*
Species	*A. brassicae*

IDENTIFICATION AND MORPHOLOGY OF PATHOGEN

A. brassicae. The mycelium is septet light-colored, Brown to brownish grey, Profusely Brunched, and they are Inter and intercellular. They Mature and Produce conidiophores. The conidiophores of *A. bassicae* are generally Produced In a group, dark, Septet, and arise in fascicles, Measuring 14-74 µ × 4-8 µ. Conidia Is brownish black, obclavate, muriform with a long beak, long and wide with more septetion with transversely, longitudinally produced singly Short chains beaked and Measure 125-225 µ × 16-28 µ on maturity and their spore body length 96-114 µ, spore beak Length 15-65 µ, Longitudinal section 0-6 µ, Spore Body width 17-24 µ, overall spore length 148-184 µ, Rate of growth and sporulation on media rudimentary growth and grow slowly. Chlamydospores formed less frequently on culture media (Saha *et al.*, 2022; Meena *et al.,* 2011).

A brassicicola. Mycelium is septate and its colour differs from Grayish black to olive grey. Conidiophores are olivaceous, septate and branched. The dimensions of conidiophores range between 34-44 µ × 4.5-8.5 µ. Conidia Is Dark in colour, cylindrical to oblong, and

muriform without breaking a few septations *i.e.* 3 to 10. Its spore body length ranges between 44 µ -54 µ, whereas its spore body width ranges between 12 µ -17 µ. The spore beak length is not found in this species. Its overall spore length ranges between 46 µ -56 µ. If we talk about the septation of this species, i.e. transverse septation 4-8 and longitudinal septation 0-5. It produces well-developed black sooty colonies with distinct zonation, grows faster and sporulates abundantly, Chlamydospore are not formed or seen on the cultural media (Kumari *et al.,* 2020; Meena *et al.,* 2011).

A. raphanin. Mycelium is Cottony whitish to greenish grey or dark olive in colour. Conidiosphores are septate, simple or branched and olive brown in colour that measures between 28-161 × 4-8. Conidia is olive-brown to dark in colour, obclavate, muriform with poorly developed or no breaks, which is usually wider than those of A. brassicae, less uniform in shape than either of the two species, more or less pointed at each end, appear singly or in chains of upto 6 spores. Its spore body length ranges between 46 µ-59 µ, whereas spore body width ranges between 12 µ 20 µ. The spore beak length ranges between 11–26. Its overall spore length ranges between 59 µ-82µ. If we talk about the septation of this species, i.e. transverse septation 6-9 and longitudinal septation 4-7. It produces a cottony mycelia colony, which distinguishes it from other species and it has less abundant sporulation capacity on cultural media. Chalmydospores are usually olive brown in colour which is generally found on the partially decayed and affected plant parts on cultural media (Meena *et al.,* 2011; Saha *et al.,* 2022).

SYMPTOMOLOGY

A. brassicae. Symptoms usually appear in leaves, stems and siliquae. It affects the host plant at all stages of growth along with the seedling stage. It produces spots which are generally grey in colour. Its symptoms are mostly similar to *A. brassicicola* but it tends to be smaller and lighter in colour (Blagojević *et al.,* 2020)

A. brassicicola. Symptoms of the disease are characterized by the formation of spots on the leaves, stems and siliquae. It affects the host plant during the seedling stage, including dark stem lesions after germination, which usually leads to damping off or stunted seedlings. The spots formed by the A. *brassicicola* are black sooty velvety. The spots are dark in colour which further expands and becomes circular along with concentric rings (Nowakowska *et al*., 2019).

A. raphani. Spots are formed on the leaves which are spherical to elliptical in shape with yellow in appearance. It consists of concentric rings which dry in the central region. The leaves mostly drop out of the plant. The symptoms first appear on the lower leaves with black points which further develop into concentric rings. The symptoms vary with the host and environment. As time pasts, the disease appears on the middle and upper leaves with smaller-sized spots during the defoliation of lower leaves occurs (Gusain *et al.,* 2020).

Yield. All rapeseed-mustard growing regions across the world experience Alternaria blight every year. According to Kolte (1985a,b); Kolte *et al.* (1987, 2002); Meena (2005); Kolte *et al.* (2002), mustard yields are lost on average by 35–38%, yellow sarson by 46-47%, and Brassica species by up to 70% as a result of this disease. Due to this disease, yield losses of 20 to 30 per cent were reported in Canada (McDonald, 1959; Conn *et al.*, 1990). (Thejakumar and Devappa, 2016; Kumar, 1986; Ram and Chauhan 1998) show losses ranging from 15% to 71% claimed by various workers in India. According to Kolte *et al.* (1987), the disease results in losses of 23 and 24%, respectively, per 1000-seed weight (g) of yellow sarson and mustard. In addition to quantitative loss, the fungus infection also causes a reduction in seed quality in terms of seed size, seed colour, and oil content (Kaushik *et al.*, 1984; Kumar, 1997). Degenhardt *et al.* (1974) reported a loss in oil content of up to 4.8%, however, Ansari *et al.* (1989) found reductions in oil content of rapeseed cultivars between 14.58 and 35.97% and mustard cultivars between 14.12 and 29.07% in India. According to Rotem (1994), *Alternaria* black spot could cause disastrous yield declines of 25–50% in crops like canola or rape.

Fig. 1. a. leaf spot by *A. brassicae*, leaf spot, **b**. leaf spot by *A. brassicicola,* ***c.*** leaf spot by *A. Raphani* **d**. Necrotic patches, **e, f, g, h, i** – *Alternaria spp.* Attack on various plants parts, **j.** *A. brassicae microscopic view,* **k**. *A. brassicicola microscopic view,* **l.** *A. Raphani microscopic view* (Kumar *et al.,* 2014).

Survival of pathogen. Scientists have noted that this pathogen can survive in tropical and subtropical areas of India by binding itself to damaged seeds or contaminated plant debris. Oilseed Brassicas are sown in India between late August and November, depending on the crop and its variety. Oilseed Brassica seeds are completely favoured by the availability of soil moisture, temperature, and weather for germination and From February to May, there is harvest. From May to September, non-traditional locations grow crops during

the off-season. The reason for transferring *A. brassica* from one crop season to the next season is due to this, along with the fungus caused by vegetable Brassica crops and alternate hosts like (*Anagllis arvensis*) (Meena *et al.,* 2016). Therefore, it is known that airborne spores are the main source of inoculum for these polycyclic diseases.

Pathogenicity and disease development. The conidia of *Alternaria spp.* quickly germinate when moisture is available by inducing any cell to create a germ tube. A spore's cells May occasionally all begin to grow, giving rise to several germ tubes. *A. brassicicola* enters the leaf tissue directly as well as through the stomata, in contrast to *A. brassica*, which only enters the leaf through the stomata. Direct penetration in the case of *A. raphani* is well recognized. More spots start to show up three to four days after the immunization. Through the stomatal hole, *Alternaria brassica* enters the leaves. Three to four days after infection, newly formed spots start to generate spores (Butler, 1918). *Alternaria brassicicola*, on the other hand, penetrates the host directly through the development of appressori (Hung and Chung 1993).

Cellulose enzymes and toxins that assist in the development of infection and disease are produced by A. brassica (Nehemiah and Deshpande 1976a, 1977b). Degenhardt *et al.*, 1974; Durbin and Uchytil 1977). Although it is unknown exactly how this enzyme or toxin contributes to disease. *Alteraria brassica* produces at least three phytotoxins through its multi-toxin system. *A cyclodepsipeptide* with the chemical formula CyaH, N, O is destruxin B. Its molecular weight is 593. According to Hussain and Thakur (1966), the pathogen's culture filtrates cause severe wilting and water-soaked patches in yellow mustard cuttings within 12 hours. This study posits that the toxin produced by *A. brassica* may be the cause of the rapeseed and mustard leaf blight.

Dubey *et al.* (1980) claimed that the culture filtrate increased the host cell's permeability and led to an electrolyte loss. The semi-purified preparation of culture filtrates contains two types of non-specific toxins that cause disease symptoms in leaves, according to studies. Destruxin B, a cyclodepsipeptide originally found in the culture filtrates of *A. brassica* and shown to be host-specific, was later found to be identical to a purified form of the toxin (Ayer and Pena- Rodriguez 1987; Bains and Tiwari 1987). The symptoms that are produced on different Brassicas by the toxin and the fungus differ in severity from overt chlorosis and necrosis to practically none at all. Phytotoxins are sensitive to different Brassicas in a similar sequence to their susceptibility to *A. brassicae* (Bains and Tiwari 1987).

The phytotoxin destruxin B of *A. brassicae* was examined for host specificity in 30 different plant species, but none were found Necrosis and chlorosis symptoms appeared on both the host plant and plants that weren't the host. However, there were observable differences in how sensitive to destruxin B various taxonomic plant groupings *Brassica* spp. were the most sensitive to the toxin, and as the degree of relatedness between plant groupings increased, so did the toxin's toxicity. Destruxin B has a host-selective characteristic since no genotypes of the Brassica species have been found to be particularly susceptible to it. It is regarded as a virulent component that increases the pathogen's aggressiveness by modifying the host tissue and affecting the host's susceptibility (Buchwaldt and Green 1992), two more destruxins produced by A. brassica, homodestruxin B and destruxin B, are also phytotoxic to the leaves of oilseed rape (Ayer and Pena- Rodriguez, 1987; Buchwaldt and Jensen, 1991). Homodestuxin B is non-host specific in nature and, like destruxin B, induces symptoms of varying severity on the leaves of numerous non-host plant species (Bains *et al.,* 1993). *B. napus* leaves infected with *A. brassicae* contain a plant growth regulator that is hostile to dextruxin B.

Epidemiology. The disease first manifests as a primary infection on lower, dew-covered leaves during the early morning hours. This serves as the inoculum for secondary infection. During the time when crops are growing, the relative humidity fluctuates between 46 and 96% during the day and 73 and 92% at night. RH 91.5% and 87%, respectively, are necessary for sporulation in *A. brassicae* and *A. brassicicola* on naturally infected leaf discs of oilseed rape. The ideal temperature for conidia germination in artificial media is 20–23 °C for *A. brassicae* and 22-32 degrees C. *A. brassicicola. A. brassicae* and *A. brassicicola* both require free water and an ideal temperature of 15 or 25 °C to infect the crop, respectively. Infection must begin at least 16 hours after exposure, and disease must progress optimally between 48 and 72 h.

Both pathogens develop spores in 12–14 h at the ideal temperature for sporulation, which is 18–24 °C for *A. brassicae* and 20–30 °C for *A. brassicicola*. Sporulation is hindered at 24 °C (Singh, 2009). The sporulation of either fungus was unaffected by a 16-hour wet period interrupted by a 2-hour dry interval of 70 to 80% relative humidity, but both were inhibited by a 3- to 4-hour dry interval of the same humidity. The concentration of spores produced during the wet phase is unaffected by exposing both fungi to alternate wet (18 hrs at 100% RH, 20 °C) and dry periods (6 to 30 hrs at 55-65% RH, 20 °C). The type of host or the age of the host tissue has no bearing on sporulation times (Humpherson-Jones and Phelps 1989). Growth benefits more from alternating light and darkness than from constant light or darkness (Ansari, 1989).

The age of the plant, the ambient temperature, and the length of the host surface's wetness all affect how susceptible oilseed *brassicae* are to *A. brassicae* (Chahal, 1986; Mridha and Wheeler 1993; Hong and Fitt 1995). From 21 to 71 days following germination, the disease's severity increases with plant age (Sinha, 1992). The rosette and blooming stages of the crop were when leaf disease severity peaked (Meena *et al.,* 2016). Maximum infection was seen on pods at 20°C and at 25°C for older leaves of oilseed rape. Lower temperatures require a longer minimum-wetness period before leaves and pods become infected than higher temperatures do. At 18°C, an infection required a wetness period of at least 4 hours, and the severity of the disease increased with longer wetness periods (up to 12 hours). In contrast to initial wet periods, dry periods followed by wet periods prevented lesion growth on

leaves, but when pods were rewetted, some diseases spread to other parts of the plant (Mridha and Wheeler 1993). A 16–24 hour interval of leaf wetness at a critical temperature of 25°C is required in rapeseed and mustard for high infection (Saharan and Kadian, 1983). A maximum and minimum daily temperature of 18 to 27 C and 8 to 12 C, as well as more than >92% and >40% morning and afternoon relative humidity, respectively, in the previous week, were all factors that were found to be positively correlated with the severity of Alternaria blight on leaves, according to Meena (2005).

Maximum daily temperatures of 20 to 30 degrees Celsius, daily average temperatures of 14 degrees Celsius, morning and daily mean relative humidity values of >90% and >70%, >9 hours of sunshine per day, and >10 hours of leaf wetness were all favourable conditions for disease severity on pods. Mehta (2014) found that conditions that were favourable for the development of the Alternaria blight included temperatures between 20 and 25 degrees Celsius, a low of 15 degrees Celsius, a morning relative humidity of 90% or higher, and an evening relative humidity of 70% or higher. Sangeetha and Siddaramaiah (2007) discovered a connection between disease onset and the greatest temperature in Bangalore (Karnataka). According to their research, a maximum temperature of 26 to 29 °C and an average relative humidity of >65% were favourable conditions for the development of disease. According Bal and Kumar (2014), Punjab's average RH of more than 70% and mean temperatures between 13.5 and 19.3 C were favourable for the Alternaria blight. Disease occurrence is also influenced by the number of inoculums. On spring rape's *B. napus cv*. Starlight pods, the disease's incidence increased from 80 to 104 spores mi'; however, further increases in inoculum concentration only increased the severity of the disease, not its occurrence (per cent of pod diseased). Temperature (6-20°C), wetness duration (2-12 hrs), inoculum concentration (2 × 103 spores/ml), and leaf age all contributed to a shorter incubation period (4–10 days). The incubation period generally decreased dramatically with an increase in lesion density (Hong and Fitt 1995).

The severe Alternaria blight infections in India were frequently favoured by cloudy conditions (Butter, 1918). Disease development and weather-related variables are positively connected. "Severe blight is connected with low temperature (lowest 2-12°C, maximum 16-26°C), high RH (80-96%), average rainfall of 30 mm, and wind velocity of 2-6 km/hrs", claims Sinha *et al.* (1992); Dang *et al.* (1995); Gadre *et al.* (2002). The development of the disease in the epiphytotic form at Ludhiana, Punjab, was attributed by Chahal and Kang (1979 a,b) to an average temperature of 18°C, the occurrence of regular rain, atmospheric humidity of 80% or over, stormy weather combined with high air velocity during flowering and pod formation stage, and frequent precipitation. Gupta *et al.* (2003) found a correlation between the weather factor and the development of Alternaria blight and that 85-day-old plants exhibited the highest disease severity. They also discovered a negative correlation between maximum and minimum temperature and a positive correlation with relative humidity. Yadav and Brar (2003) observed higher susceptibility to the disease during the rosette to flowering stage of the -group, when relative humidity varies from 81-94% with a total number of rainy days of pf 4-11 days. The first week of February was when yellow sarson disease development in Faizabad peaked, according to Kumar *et al.* (2014). This was made possible by average minimum and maximum temperatures of 8.6-9.90°C and 22-25°C, respectively, as well as minimum and maximum relative humidity levels of 50-70% and 85-95%, respectively.

MANAGEMENT OF DISEASE

Cultural control. Before the sowing of seeds, the field and its surrounding must be cleared of weeds so that the disease should be controlled. Seeds that should be used for sowing must be of good quality. As in north India, Alternaria blight is controlled if the sowing of seeds are done in the mid – October. In West Bengal if the sowing is delayed by 1 month, *i.e.* beyond 22nd October, the possibility of disease is increased. Seed rate and crop density per unit area plays important role in the occurrence of the disease and yield. If we apply high fertiliser doses such as nitrogen then the severity of Alternaria blight is increased in oil seed rape. While using nitrogen and potash (92 kg Nha^{-1} + 41 kg K_2O $ha^{-1)}$ decreases the disease severity and increases the yield off mustard under the field conditions. If we use N P K in the recommended dose is 90: 60: 40 kg per ha along with 40 KG sulphur per ha then the Alternaria blight is controlled on a large scale. Appling minerals like sulphur, potashas, borax, and zinc in the effectively controls of Alternaria blight of mustard (Kiran *et al.* 2022).

Biological control. Nowadays in modern agriculture, improper and indiscriminate use of chemical pesticides creates many serious problems like resistance, pest resurgence and environmental issues like pollution, reduction of beneficial insects etc.

Till now chemical management was a key tool against the problem of *A. brassicae* and *A. brassicicola* however some research shows the possible alternate improvement and effective management of this problem as biological management i.e., it indicates the possibility of controlling the disease with the use of some microbes for an example, *Streptomyces arabicus* is a natural enemy of *A. brassicae*. Metabolites called Fistupyrone which is found in *Streptomyces* spp. Strain TP-A0569 inhibit the germination of spores of *A. brassicicola*, but it is not effective for other *Alternaria spp.*

According to Pace and Camphell -1974 in the case of phyllosphere, residents use Aureobasidium pullulans and Epicoccum nigrum 14 hr before the pathogen also reduce the infection caused by *A. brassicicola* Some other biological such as *Trichoderma* viride pseudomonas fluorescence at 45 and 75 days after sowing can manage the problem of Alternaria blight (Meena *et al.,* 2005, 2011).

In biological management, some botanicals also play a key role in the management of disease incidence for example, in India mustard (*brassica juncia*), and extract

of garlic (*Allium Sativ*) has been reported to effectively management of Alternaria blight. S, the use of garlic extract in combination with *Trichogaderma* spp. with fungicides like Mancozeb was reported effective in controlling Alternaria blight disease severity at different places. The use of garlic extract and Eucalyptus globulus is also effective in the control of Alternaria blight and work as an eco-friendly substitute for chemical fungicide.

Chemical control. The use of chemicals is a very effective way of controlling the A. blight in mustard, before sowing of seed, treatment is compulsory for controlling the disease. Seeds should be treated with brassicola or captogal @4g and carbendazgim @2.5g or mancozeb @ 2g/kg in order to control the seed-borne infection off a *brassicae* iprodione (02%) controls the disease at a higher rate. Iprodione disease defoliation increases crop yield by up to 10% (Glory *et al.,* 2022).

Fungicide spray should be done when height is the first appearance of the disease sport and then it should be repeated two to three times at 10 to 15 days intervals depending on the crop variety growth stage and the severity of infection in the mustard rape seed. It we are applying the fungicides after the flowering stage, it protects the plant from infection also increase the germination of harvested seed *i.e.* yields under field conditions some resistant including chemicals such as benzoic acid, naphthenic acid, acetic acid salicylic acid, phosphoric acid, is nicotinic acid were identified effective for the control of Alternaria disease in the mustard rapeseed (Singh *et al.,* 2017).

CONCLUSION

Pathogenic *Alternaria species* are global and severe, making Alternaria leaf blight the most destructive disease of oilseed *brassicas* worldwide. Alteraria blight reduces the quality and quantity of oilseed *brassica* harvests, and no resistant crop species have been found. However, coenospecies (wild species) of *Brassicas* such *B. desnottesi, C. sativa, C. pseuderucastrum, D. berthauti, D. catholica, D. cretacea, D. erucoides,* and *E. gallicum* were entirely resistant to *A. brassica*. Other techniques might handle Alternaria leaf blight as grown *Brassicas* lack resilience.

Fungicides are widely utilised. Despite their widespread usage against infections, fungicides pose substantial health risks and pollute the environment. Thus, moderately resistant cultivars, plant and natural products, bio-control agents, and agronomic changes are increasingly prioritised for disease management since they are more cost-effective, eco-friendly, and safe.

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