STUDIES ON ALTERNARIA BLIGHT OF SOME OILSEED CRUCIFERS

ABSTRACT

Oilseed crucifers particularly rapeseed (Brassica campestris L.) and mustard (B. juncea (L.) Czern and Coss) are grown on a large scale in India occupying nearly 3,892.7 thousand hectares of land. The state of Uttar Pradesh ranks first in acreage and in production of oilseed crucifers in the country. Currently, there is great emphasis in India on increasing the production of oilseeds including oleiferous crucifers since the current production is much below the requirements of the country. At present, the productivity of oilseed crucifers in India is very low and there is a great need to enhance it to meet the ever increasing demand in the country. This can be accomplished by using improved agro-techniques, growing high yielding cultivars and adopting adequate control measures against pests and diseases.

Rapeseed and mustard are attacked by a number of pathogens causing enormous loss to growers. White rust of crucifers caused by Albugo candida, downy mildew caused by Peronospora parasitica and Alternaria blight caused by species of Alternaria viz., Alternaria brassicae (Berk.) Sacc., A. brassicicola Wilt. and A. raphani Groves and Skolko are recognised economically important fungal diseases. Out of these Alternaria blight caused by A. brassicae is
considered as most destructive as the pathogen attacks plants in different stages of their growth and development. Seedlings are infected resulting in their damping-off. Leaves, stems and pods are blighted by the pathogen resulting in great reduction in yield.

Although the existence of the pathogen, *A. brassicaceae* on crucifers is known since 1928 in India, no systematic work on the various aspects of the pathogen; the disease and its control has been done in the country. In view of the importance of oilseed crucifers in the national economy of the country, various aspects of Alternaria blight disease of rapeseed and mustard, one of the important stumbling blocks in raising the productivity of oilseeds, were investigated. These aspects included the study of the symptoms of the disease; studies on morphological and cultural characters of the causal organism; effect of various factors and different nutrient sources on growth and sporulation and spore germination of the pathogen; observations on survival and perpetuation of the pathogen; host-age of the crop as a factor in susceptibility; relationship of atmospheric temperature and relative humidity and disease development; ascertaining the effect of the disease on oil and protein content of rapeseed and mustard; host range studies of the pathogen; and control measure studies.

Field study of the symptoms of disease caused by *A. brassicaceae* showed that the disease appears at two different
stages of plant growth. At seedling stage, damping-off of the seedlings occurred. The aerial parts of the seedlings that could emerge and survived were infected later. After the emergence of the seedlings, the lower leaves were first to be attacked on which circular spots with concentric rings appeared which gradually enlarged and coalesced with each other tending to cover large areas of the leaves. Almost all the leaves of the plants gradually developed such symptoms. The stems and pods were also attacked. Elongated lesions appeared on stems which eventually developed black sooty colour. Lesions also developed on pods. Severely attacked leaves and pods died and withered. The identity of the fungus causing blight of rapeseed and mustard was established as *Alternaria brassicae* (Berk.) Sacc, based on its morphological characters and pathogenicity tests.

Cultural and morphological characters of the pathogen *A. brassicae* were studied on various solid and liquid media. Variations in colony characters were observed on different solid media. Potato dextrose agar medium amongst the solid media and Kirchoff's medium amongst the liquid media were found as best for its growth and sporulation. Consequently potato dextrose agar medium and Kirchoff's medium were selected as solid basal medium and liquid basal medium respectively.
The growth and sporulation of the pathogen was found to be influenced by temperature, relative humidity, pH as well as exposure to light and darkness. The growth of the pathogen occurred at a range of temperature from 5 to 30°C tried in the experiment. The growth was greatest at 23°C. A similar trend was obtained in sporulation. Alternate light and darkness was favourable. The growth and sporulation was comparatively poor in continuous light and complete darkness conditions. The pathogen was able to grow at all the relative humidity levels tried. Gradual increase in relative humidity correspondingly enhanced the mycelial growth and sporulation. The optimum range for mycelial growth was 95-100 per cent. It peaked at 100 per cent. Mycelial growth of the fungus occurred at all the pH levels tried, the highest being at 6.5. An increase or decrease from this level (pH 6.5) gradually supressed its growth. Sporulation was noticed at all the levels except 2.9 and 9.2.

Studies of the nutritional requirements of the pathogen were undertaken to assess the relative efficacy of different kinds of nutrient sources. All the carbon sources favourably influenced growth of the pathogen. Without carbon, growth was very poor. Among the different sources applied, starch emerged best followed by cane sugar and sucrose. Similar effects of different nitrogen sources were observed on its growth. Peptone was found as best source. Absence of any source of nitrogen (control) drastically checked its growth. The influence on sporulation, however, varied.
There was no correlation between fungal growth and sporulation. Some of the amino acids improved its growth considerably while others inhibited its growth and sporulation. DL-threonine was the best amino acid for improving its growth and sporulation.

Addition of different sulphur and phosphorus sources significantly enhanced growth and sporulation of A. brassicae. Response to various sources used, however, varied. Amongst the phosphorus sources, performance of dibasic potassium phosphate was best. Similarly potassium sulphate was best amongst sulphur sources. In these studies, a positive correlations between extent of mycelial growth and sporulation were observed.

Response of the pathogen to various vitamins and growth regulators indicated that the pathogen was prototrophic, requiring no exogenous supply of vitamins or growth regulators. Some of the vitamins and growth regulators accelerated its growth whereas the others were inhibitory. Biotin, nicotinic acid, ascorbic acid and thiamine among vitamins and Beta-indol butyric acid and 2,4-dichlorophenoxy acetic acid among growth regulators increased its growth considerably.

Effect of temperature and relative humidity and different nutrient sources on spore germination were studied under controlled conditions. More or less similar trends in their effects were observed as in case of effects on growth
and sporulation. The optimum range of temperature for spore germination was found as 21-25°C, the best being 23°C. Maximum germination occurred at 100 per cent relative humidity. Starch and peptone were best carbon and nitrogen sources respectively for influencing highest spore germinations. Glycerol among carbon sources and ammonium molybdate among nitrogen sources effected lowest spore germination. Effect of majority of the vitamins and the growth regulators was adverse on spore germination. Biotin, nicotinic acid and ascorbic acid among vitamins and Beta-indol butyric acid, 2,4-dichlorophenoxy acetic acid and Alpha-naphthalene acetic acid, however, did not suppress spore germination. Spore germination was considerably high even in the absence of any vitamin or growth regulator which indicated that the pathogen has no requirement of exogenous supply of these substances.

The studies undertaken to ascertain the mode of survival and secondary spread of the disease demonstrated that the pathogen remains viable in diseased plant debris and seeds of infected plants and they serve as primary sources of inoculum. Additionally, the pathogen was found to be internally seed-borne and the infected seed were thus found to be the cause of damping-off of seedlings as observed in field study. Air-borne conidia produced on the aerial parts of the infected plants were found to be responsible for secondary spread of the disease.
Studies to determine the most susceptible age of the plant showed that the 10-day-old plants were most vulnerable to the attack of \textit{A. brassicae}. The susceptibility gradually declined with an increase in the age of the plants. An incubation of 48 h in moist chamber was found necessary for the disease development. Highest disease intensity, however, occurred on plant incubated for 72 h. Environmental factors like temperature and relative humidity influenced the disease development greatly under field conditions. The temperature conditions and the relative humidity levels prevailing during first fortnight of December to second fortnight of January were best for the disease development. These conditions may be considered congenial for the out-break of the disease.

The attack of the pathogen on the crops of rapeseed and mustard was found to reduce the oil content of the seeds. The extent of reduction, however, varied depending upon the variety involved. But slight increase in protein content of the seeds occurred.

It emerged from host range studies which included 50 plant species belonging to 15 families that \textit{A. brassicae} has a restricted host range. All the plants of the family Brassicaceae were readily attacked by the pathogen. Outside the family Brassicaceae, only three plants viz., \textit{Chenopodium album} (Chenopodiaceae) \textit{Convolvulus arvensis} (Convolvulaceae), \textit{Anagallis arvensis} (Primulaceae) were infected by the pathogen.
Screening of cultivars and fungicidal applications were tried as measures of control for the disease. A large number of cultures/varieties of rapeseed and mustard were observed for their reaction against the pathogen under natural conditions in the field. Some of the cultures/varieties of mustard were found to be free from the disease and a few others showed a varying degree of resistance. Some of the cultures/varieties of rapeseed were also moderately resistant under field conditions. In artificial inoculations, all these cultures/varieties showing different degrees of resistance became susceptible or highly susceptible.

In control studies with fungicides, all the fungicides included in the test when incorporated in the medium (PDA) inhibited mycelial growth of the pathogen. Dithane M-45, Dithane Z-78, Ziram, Difolatan-80, Blitox-50, Thiram, Brestan-60 and Benlate completely checked its growth. Rest of the fungicides were not so effective but arrested the growth to a varying extent. Further studies on fungicides in which total inhibition in growth was observed revealed that six of them were fungicidal in action. Thiram and Benlate were, however, fungistatic.

Studies were undertaken to examine the effect of the six fungicides which were totally inhibitory to mycelial growth of the pathogen in vitro and fungicidal in action on damping-off of the seedlings under controlled conditions.
Seed dressing with the fungicides was effective in controlling the pre-and post-emergence damping-off of the seedlings. Their efficacy, however, varied. Performance of Penlate was best followed by Dithane M-45.

The six fungicides were further tried for two consecutive years as foliar spray to ascertain their efficacy in controlling the disease in crop fields. Dithane M-45 emerged as best in reducing the disease intensity and improving the yield. Rest of the fungicides were also effective to a great extent in this respect.

A schedule of spraying with Dithane M-45 was worked out, taking the disease intensity and economics of inputs and output into consideration. A schedule of four sprays at 15 day intervals when the crop was a month old was found to be economically most profitable.