DISCUSSION AND SUMMARY
DISCUSSION

Buckeye rot of tomato caused by *Phytophthora parasitica* Dast. has been reported from a number of countries, but in India the disease has assumed importance only in Himachal Pradesh in areas having good rainfall at elevations ranging from 800 to 1700 meters above sea level, attacking mostly the fruits under natural conditions. In this Pradesh the disease has been recorded from almost all the districts except Lahaul and Spiti region of Kulu district and Kinnaur district, with varying intensities attacking 25 to 45 per cent of the fruits with a total annual loss of about three million rupees. The restricted occurrence of buckeye rot poses an interesting problem, i.e., whether the pathogen is likewise limited in its distribution or is it present over large areas, but becomes destructive only in areas having favourable conditions. Diseases incited by various species of the genus *Phytophthora* are generally greatly influenced by climatic conditions, e.g., late blight of potato, sesame blight, and koleroga of arecanut caused by *Phytophthora infestans* (Mont.) deBary, *P. parasitica* (Dast.) var. *sesami* Prasad, and *P. arecae* (Coleman) Pathy, respectively. The restricted occurrence of the disease in different areas of the Pradesh might be due to the prevalence of favourable environmental conditions in these regions only. The contention is amply proved by the fact that in Lahaul and Spiti and in Kinnaur district the disease is not present because of lesser rainfall and low temperature. At lower elevations, i.e., below 800 m.a.s.l. the crop is not taken during the summer months because of high temperatures, allowing only the winter crop. However, stray incidence of the disease is sometimes observed at lower elevations if the crop is available in the field up to the end of April or beginning of May and prolonged unseasonal showers are received. The high incidence of the disease,
as observed in some of the localities in this Pradesh, has also been reported from Indiana by Kendrick (1923) and from Eastern Transvaal by Wager (1935). Of course, variation in incidence of the disease at different places may not only be due to resistance or susceptibility of the varieties grown in those localities but also due to the pathogenic variation in the isolates of the fungus itself and other environmental factors.

Blossom blight was also observed in addition to damping-off, collar rot, stem canker, and fruit rot as reported by different workers (Bewley, 1921; Taylor, 1924; Samuel, 1930; Goidanich, 1936 and Richardson, 1941). Two types of symptoms on fruits, i.e., fruit rot with and without zonations as recorded by Richardson (1941) were observed for buckeye rot. The infection mostly appeared at the blossom end of unripe tomato fruits. These are in conformity to the observations made by Critopoulos (1954), who reported that small and full sized green fruits were equally susceptible to *F. parasitica*, but Obero and Aragaki (1965) have reported symptoms on both mature green and fully ripe fed tomato fruits. In nature the infection usually takes place at the blossom end, though under laboratory conditions all sides of the fruit were found to be more or less equally susceptible. It may be due to direct facing of the blossom end side towards the source of inoculum which perpetuates in the soil and is splashed over to the fruit surface by rain. Secondly, it may also be due to the accumulation of the inoculum and better conditions for germination of zoospores because of the presence of free water which accumulates and remains there for a longer period after rains and helps in the initiation of infection. Chances of lower fruits coming in contact with the soil harbouring the fungal inoculum are also more as compared to the upper fruits, hence they
show more disease incidence and are usually attacked first.

Histological studies conducted have revealed that the fungus behaved in a similar manner as *P. capsici* Leon. on tomato fruits as reported by Simonds and Kreutzer (1944). However, the fungus was found to be internally seed borne, where it was present both inter- and intra-cellularly in the endosperm and the ovule. Probable seed borne nature of *P. parasitica* on tomato had also been recorded by Alcock (1931) from diseased tomato fruits.

The morphological and cultural characters of the fungus agreed closely with those given by Dastur (1913), Richardson (1941), and Waterhouse (1963). The zoospore number recorded in the present studies varied from 8-16 per sporangium, rarely approaching 25. Dastur (1913) had also recorded 5 to 45 zoospores per sporangium. The fungus showed good growth on oatmeal agar (filtered and unfiltered), corn meal agar and okra seed extract agar. Except for okra seed extract all these media have already been tried by a number of workers and are reported to be good for the growth of different species of *Phytophthora*. It was further observed that gnarling of mycelium and submerged growth of the culture were some of the characters associated with the media which did not favour good vegetative growth of the fungus. Under cultural studies sucrose was found to be best carbon source utilized by the fungus whereas maltose gave poor growth. The finding is contrary to that of Mahrotra (1951) who found maltose to be best utilized by the fungus. However, temperature, pH and relative humidity requirements of the fungus agreed closely as recorded by Richardson (1941).
No oospores were observed either on naturally infected tissues or in culture on different media. These findings are contradictory to those of Dastur (1913) who got abundant oospore production on french bean agar and oat juice agar, and that of Thomas (1940) who got these on maize meal agar, and Richardson (1941) who observed them on naturally infected tomato roots. Imperfectly formed oospores (without antheridial attachment) were, however, observed on corn meal agar. Mori and Yoshida (1959) also obtained imperfect oospores in cultures of *P. infestans*. Savage and Clayton (1962) and Handrich (1965) reported *P. nicotianae* var. *parasitica* (*P. parasitica*) to be heterothallic and bisexual. Waterhouse (1963) also recommended pairing of cultures of opposite strains for inducing oospore production. All the 20 isolates of the fungus obtained from different localities and fruits showing different types of symptoms were paired in all possible combinations, but none of the combinations could produce any oospore. The overwintered cultures, however, produced oospores in abundance in the diseased tissues of damped-off tomato seedlings. Oospores were also abundantly produced when the overwintered fungal inoculum was directly cultured on corn meal agar. A few oospores could also develop when young damped-off seedlings taken from the naturally infected nursery were allowed to rot under water. This lends credence to the belief of Savage et al. (1968) who observed that all *Phytophthora* species were potentially homothallic. The production of oospores in the present case may be due to the absorption or adsorption of some stimulatory substance by the fungus mycelium from the soil. The role of stimulatory substances in production of oospores has also been reported by Galloway (1936) in *P. meadii* and in *P. colocasiae* by cultural filtrates of oospore bearing cultures,
Zentmeyer (1952) for P. cinnamomi by a substance present in avocado roots and Hendrix (1965) in case of P. nicotianae var. parasitica (P. parasitica) by cholesterol. Kleiner and Lenney (1965) have also emphasized the role of lipids in stimulating the sexual reproduction and growth of Pythiaceous fungi. However, the oospores did not germinate by various methods tried. Difficulty in oospore germination has amply been brought out by Blackwell (1943). It may be possible that the fungus requires some specific conditions for oospore germination which were not provided during the course of present studies.

Cultural and pathogenic variability in the present fungus was studied with 20 different isolates and highly significant differences were observed among them. Interaction of media and isolates was also highly significant. All the isolates gave maximum growth on okra seed extract agar except isolate 7 and 16, which showed better growth on corn meal and unfiltered oatmeal agars, respectively. Isolates 26, 8, 18, 6, 12, 23, 11, 16, 15, 17, 1, 4 and 10 were more virulent than others, namely, 25, 3, 13, 20, 5, 9 and 7. Variation in natural populations in the genus Phytophthora is common and has been reported for many species, primarily with a view to finding out physiologic races e.g., for P. infestans (Black, 1952; Waggoner and Wallin, 1952). Recently pathogenic and cultural variation has also been reported in P. nicotianae var. parasitica (P. parasitica) by Siradhana et al. (1968) who had taken cultivars of the fungus from different hosts. In the present studies cultural and pathogenic variation has been observed among cultivars of P. parasitica taken from the same host species. However, no correlation between the mycelial growth and virulence of the pathogen could be observed and this finding is in conformity with that of D’Yakov et al. (1966), who
also could not find any correlation between spore germination and virulence in *P. infestans*.

Under epidemiological studies it was observed that the disease appeared almost simultaneously in most of the localities around Solan during the later half of June, depending on the onset of monsoon rains which resulted into increased humidity in the atmosphere and was essential for initiation and development of the disease. The fruits at lower heights (1-15 cm.) got infected first and showed more disease incidence than those at upper heights (15-30 cm. and 30-45 cm.). Similarly, Sherbakoff (1917) recorded serious losses to fruits touching or nearly touching the soil. Eastham (1922) also reported more damage to lower fruits in a Victoria green house. The infection on the lower fruits mostly takes place directly from soil through mycelium or zoospores of the fungus present in the soil, whereas on the upper fruits it may be due to the zoospores released from sporangia produced on diseased fruits and disseminated by rain water or wind.

The disease incidence varied directly with variations in environmental and soil conditions. The disease was severe during the months of July and August when the atmospheric temperature during day and night ranged between 28°-20°C. The incidence decreased during the month of September when the temperatures dropped down to 24°-13.5°C. During the months of July and August both temperature and humidity were ideal for the production of sporangia, which were abundantly produced at temperatures ranging between 21°-25°C. Their germination was optimum at 25°-30°C in a saturated atmosphere on account of monsoon rains. During this period the temperature and humidity were also ideal for fruit infection being maximum at 25°C
at 98.5-100 per cent relative humidity. In September both
temperature and humidity dropped down because of lesser precipitation
resulting into conditions which were not conducive for initiation of
infection. Soil moisture was also found to be an important factor
for disease development. High soil moisture was correlated with
increased disease incidence. Similar observations were also made
by Wager (1935) who reported that the disease occurred during summer
months in Eastern Transvaal and was favoured by rainy weather.
Richardson (1941) also obtained similar results experimentally.
Rosenbaum (1920) emphasized the role of abundant moisture supply,
preferably free water in diseased soil, for the epidemic spread of
the disease.

Nitrogen application to the soil directly increased the
incidence of the disease. Among the three doses of N applied, viz.,
40, 80 and 120 kg./hectare, the incidence of the disease rose to
51.6, 60.3 and 67.1 per cent from 40.1 per cent in the control. The
effect of phosphorus was slight and it reduced the disease incidence
to 31.7 per cent at 90 kg./hectare, though low doses showed little
effect. Potash had no appreciable effect either way. Whether the
increase in the incidence of the disease as due to increased
susceptibility of the host or increased vegetative growth of the
plants creating more humid conditions favourable for infection or
it resulted into increase in the growth of fungal inoculum in the
soil as is evident from cultural studies of the fungus where the
fungus could grow satisfactorily when N was applied in the form of
Ammonium sulphate to the medium, could not be ascertained. However,
the results are in conformity with the results of Apple (1961) in
the case of black shank disease of tobacco (P. nicotianae var.
nicotianae), where he had observed that disease indices rose at
higher N doses and that K had little effect. He also found that low doses of P reduced susceptibility in comparison to high doses, but in the present studies high doses were effective in minimizing the disease incidence.

The incidence of the disease in fields which were repeatedly put under tomato crop year after year increased during each subsequent year as could be judged from the data that the incidence rose to 45.2 and 61.2 per cent in second and third years, i.e., 1963 and 1964 from 18.2 per cent during 1962. Similarly during 1966 it was 30.9 per cent compared to 25.0 per cent during 1965. The increase in the incidence of the disease during subsequent years might be due to an increase in the inoculum potential of the pathogen in the soil, as the fungus was found to remain viable in the soil for about two years during the course of perpetuation studies.

The disease incidence, which is a resultant factor of interaction of amount of inoculum produced by the pathogen and conditions favouring infection, was found to be greatly influenced by meteorological conditions. It was found that a relative humidity approaching saturation (100 per cent) and a temperature range of 21-25°C were optimum for sporangial production. It was further observed that sporangial germination took place between 15 to 35°C, but at lower temperatures, i.e., 25°C and below the sporangia germinated through zoospores and at higher temperatures (27°C-35°C) through germ tubes. The optimum temperature for germination of sporangia was found to be 25°C for germination through zoospores and 30-33°C by germ tubes coupled with a free film of water. It was interesting to note that at both lower and higher temperatures the fungus produced abundant inoculum. At lower temperatures the
sporangia generally germinated through zoospores though their germination was comparatively less (approximately 42 per cent germination at 25°C) than at higher temperatures, whereas at higher temperatures the sporangia germinated through germ tubes and up to 60 per cent of these germinated at a temperature of 30°-33°C. Since the sporangial production was found to be very less at 35°C and above and also at 15°C and below, the temperatures found suitable for sporangial production and their germination lay between 18°C to 33°C with an optimum at 25°C. Husain and Ahmed (1961) also recorded similar results in case of \textit{P. parasitica} var. \textit{piperina}. Similarly specific requirements of temperature and humidity were also obtained in case of \textit{P. infestans} by different workers (Murphy, 1922; Crossur, 1934), except in case of the present fungus higher temperatures favoured sporangial production and their germination.

As tomato crop requires frequent picking and at each picking affected fruits are also collected and thrown away, an attempt was made at short term forecasting of the disease. It was observed that rainfall and temperature were the main factors involved in the causation of the disease, though temperature tended to be favourable throughout the crop season starting from the end of June to August, the period of heavy rains, and humidity varied directly with the precipitation received. The prediction of the disease with weekly meteorological data was found possible for which a prediction equation was given. Mean air temperatures of 20°C or less were not found suitable for initiation of the disease. At 22.5°C or higher even a slight rainfall of even 10 mm., according to prediction equation, was found to cause disease, though higher rainfall favoured increased disease incidence.
such conditions occurred the disease was expected after about 4 days (48 hours for sporangial production and 48 hours for incubation period). The disease was generally not serious before 20th June each year, therefore, the third week of June could be safely ascribed as the zero date for the appearance of the disease. No work on forecasting of buckeye rot of tea has been done so far. Late blight of potato (P. infestans) is the only disease in which forecasting has been extensively practised. Hyre (1954) also predicted late blight of potato on the basis of 10-day temperature and rainfall data. However, in case of tomato blight (P. infestans), Shkinc (1969) also resorted to short term forecasting on weekly basis, based on precipitation, minimum and maximum temperatures, relative humidity and presence of more clouds, no wind, prolonged dew and fog.

P. parasitica has been reported to have a very wide host range. An attempt was made to explore the role of various host plants in the perpetuation of the fungus and eight unrelated plants belonging to various families were found to be susceptible to infection. Of these seven are new host records for this fungus. However, none of these hosts showed any infestation under natural conditions. It is difficult to assume their exact role as collateral hosts, thus enabling the fungus to tide over unfavourable periods. The fungus was found to be seed borne, where it remained viable for about 1½ years. Probable seed borne nature of the disease had also been noted by Alcock (1931). Perpetuation was mainly found to be through mycelium present in the soil. The resistant sporangia were observed only upto one year, after which they might have germinated whenever favourable conditions for their
germination became available. The mycelium under ordinary field conditions prevalent at Solan was found to remain viable for two years, though under wet conditions it was slightly prolonged. Similarly, Richardson (1941) found the fungus perpetuating in soil for about one year. Sehgal and Prasad (1936) also reported perpetuation of *P. parasitica* var. *sesami* through mycelium in the soil for one year. Tucker (1931) got similar results and observed that capacity of *Phytophthora* species to overwinter under Missouri conditions seemed to be determined by an inherent character of protoplasm of a particular strain or species apparently not correlated with development of sexual spores or resting spores.

A large number of tomato varieties were tested against the disease. Varieties Tatinter, San Marzana, and Molokai received from Australia, Money Maker 56063 from Holland, 11-149 from Turkey, Kopiah PQ x 45727 and Red Cherry from U.S.A., Early Market (Selection) from Lalbagh, Bangalore (India), and varieties Chamba Exb.64 and Flat Large Red from Himachal Pradesh were found to be highly resistant. Similarly Felix (1948) reported eleven varieties of tomato including Yellow Pear, Fargo Yellow Pear and eight varieties bearing U.S. Regional Vegetable Breeding Laboratory numbers and apparent segregates of Sherbakoff's 57 x Oxheart resistant to the disease. Alexander and Hoover (1955) also recorded resistance of accession nos. 205004, 205011, 205016, 205022, 205026-B and 205031 to this disease.

Correlation of height of plants, ascorbic acid content, total acidity and total nitrogen content of the green fruits with the resistance of the varieties was determined. A significant inverse correlation of disease incidence with height of plants was
observed. A regression analysis conducted showed that none of the 4 factors mentioned above had any significant effect on disease incidence. However, multiple regression analysis showed that all the above factors combined together had a significant effect on the incidence of the disease. Langbein and Penl (1962) similarly reported higher nitrogen content in potato varieties which were resistant to P. infestans, but the present findings are contrary to the findings of Yamamoto (1961) who reported increase in ascorbic acid content in potato varieties resistant to the late blight fungus.

In order to mitigate losses caused by the disease, experiments were conducted to control the disease by cultural as well as chemical means. In cultural control the treatments of mulching, soil drench with Zineb and cover crop of soybean were more or less at par with each other and with the control, whereas treatments of removing fruits and foliage upto a height of 30 and 15 cm. were found best, followed by staking plus mulching and staking alone. Mulching, though not effective in the present studies, was however, reported to be promising for control of the disease by Welch (1949). Sherbakoff (1917) advocated staking of plants in the field for control of the disease, and the practice was also found effective by Wager (1935), but in the present studies the disease was rather frequently found on staked plants, as was also observed by Wilson (1956). Best results in controlling the disease by cultural means were obtained by removing the foliage and fruits upto a height of 30 cm. In this treatment the yield was comparable to that of staking plus mulching, which gave the highest yield.

For chemical control of the disease, Bordeaux mixture 4:2:50 gave the best control, followed by Bordeaux mixture 4:4:50,
Blitox, Dithane M-45, Zincop and Fycol 81 with 16.91, 18.03, 20.50, 20.97, 21.57 and 23.76 per cent disease incidence (transformed scale) compared to 39.52 per cent in the control. Though all the fungicides except Aureofungin and Streptocycline increased yields, Dithane M-45 was found to be the best followed by Bordeaux mixture 4:4:50, Blitox and Zincop. Similar results were obtained by Wager (1935), who found that spraying the plants and soil with copper containing mixtures was effective against the disease. Felix (1950) also reported good control of the disease by spraying the plants with copper oxychloride and tribasic copper sulphate. Cuwan (Ziram) which was not very effective in controlling the disease in the present studies was also not found effective by Wilson (1956).

Combining both disease incidence and yield criteria Dithane M-45, which is a mixture of Zinc and Manganese ethylene bisdithiocarbamate was found most effective both in controlling the disease and increasing yield, followed by Bordeaux mixture 4:4:50. Higher yields with Zineb were also obtained by Fulton (1954). For finding out the cause of increased yields it was observed that though significant differences did not exist among treatments as regards number of fruits and weight of individual fruits, the highest number of fruits was obtained in Bordeaux mixture 4:4:50 followed by Zincop and Dithane M-45 treatments. However, weight of individual fruits was found to be more in the case of Dithane M-45. The more number of fruits may have resulted due to the crop remaining green for a longer time as a result of the control of leaf spotting fungi.
SUMMARY

Buckeye rot caused by Phytophthora parasitica Dast. is an important disease of tomato in Himachal Pradesh. The disease occurs in all the districts of the Pradesh except the district of Kinnaur and Lahaul and Spiti regions of Kulu district and is prevalent in areas ranging from 800-1700 m.a.s.l. It spoils 25-45 per cent of fruits. The annual economic loss to the cultivators has been calculated to be about 3 million rupees. The fungus attacks the plants at all stages of their growth producing damping-off, collar rot and stem canker, blossom blight and fruit rot symptoms. Two types of fruit rots, i.e., with and without zonations were observed. This forms the major phase of the disease.

The causal organism was identified as Phytophthora parasitica Dast. (P. nicotianae B.de Haan var. parasitica (Dast.) Waterh.). Inoculum applied before or at the time of sowing the seed was more effective in causing damping-off than the inoculum applied 10 days after sowing. On artificial inoculation stems and leaves were only slightly affected, whereas the flowers were readily attacked. Maximum infection on fruits occurred when they were provided with good humid conditions up to 5 days after inoculation. Incubation period of the disease on fruits was found to be about 48 hours. Histological studies showed that the fungus was intra-cellular in the affected tissues of the fruit and attacked the seeds as well. In the seeds the mycelium was inter- and intra-cellular both in the endosperm and ovule. Under high humidity conditions the fungus produced a crop of sporangia on simple or branched sporangiophores at the surface of the fruit. On naturally infected stems and roots, the fungus was found to be both inter- and intra-cellular and produced abundant sporangia in the hollow portions of the pith in
the affected stems. No sporangia were observed inside the affected tissues.

Morphological and cultural characters of the fungus were described. Of the 16 solid and 14 liquid media tried, oat meal agar, corn meal agar and okra seed extract agar were found best for linear growth of the fungus and Lopatecki and Newton's medium followed by Richard's solution for quantitative growth. Okra seed extract agar showed maximum sporangial production. A temperature of 25°-30°C and pH of 5.0 of the medium with a relative humidity of 98.5 to 100 per cent were found optimum for the growth of the fungus. The fungus utilized sucrose, followed by galactose and asparagin followed by aspartic acid as the best sources of carbon and nitrogen, respectively.

No oospores were observed in nature. However, if seedlings affected with damping-off were allowed to rot under water, a few oospores were produced in the rotten tissues of the host. In culture, again, none of the 20 isolates produced any oospores either by themselves on different media tried or by pairing the isolates in all possible combinations on corn meal agar. However, abundant oospores were produced when the mycelium of the fungus was overwintered under soil in the field and sub-cultured on corn meal agar or when such overwintered mycelium was allowed to cause damping-off of young seedlings.

Cultural and pathogenic variation among 20 different isolates of the fungus was observed. Significant differences did exist among the isolates and among the media tried and the interaction of media and isolates was also found significant. All the isolates gave best growth on okra seed extract agar except isolates 7 and 9, which showed best growth on corn meal and unfiltered oat meal agars, respectively. Differences in colony characters were not distinct
on okra seed extract agar, whereas on corn meal agar they were only poorly defined. These were sharply defined on unfiltered oat meal agar, on which isolates 3, 6, 7, 8, 17, 20 and 23 showed loose, cottony and star shaped colonies, whereas isolates 4, 9, 12 and 15 had round, fluffy growth slightly away from the centre of the colony looking more or less like a ring. Isolates 1, 5, 10 and 26 showed loose, cottony mycelium with dimly star shaped colonies. Isolates 11, 13 and 16 were having loose cottony growth, spreading somewhat evenly on the surface of the medium. Isolates 18 and 25 had profusely fluffy aerial growth. Pathogenic variability was seen by inoculating tomato seedlings. Isolates 26, 8, 18, 6, 12, 23, 11, 16, 15, 17, 1, 4 and 10 were found to be statistically at par with each other and more virulent than isolates 25, 3, 13, 20, 5, 9 and 7. No correlation between mycelial growth and virulence was observed.

Under the epidemiological studies it was found that the disease usually started after the third week of June, became severe during July and August and declined during the month of September, with no fresh infections from October onwards. It was observed that maximum infection took place and started earlier and continued for a longer period on fruits which were up to 15 cm. height on the plants from the ground level, with decreasing incidence at 15-30 and 30-45 cm. heights, respectively, indicating the source of infection from the soil. Fruits of all ages except ripe ones were equally susceptible.

Though infection could take place between 18°-33°C, maximum infection occurred at 25°C. A relative humidity of 75.6 per cent and above was found suitable for initiation of infection and disease development with optimum at 98.5 to 100 per cent.
soil moisture was favourable for increased disease incidence. A soil moisture range of 32-35 per cent showed 17.8 per cent disease incidence, whereas at 44-47 per cent soil moisture it was 45.4 per cent indicating high soil moisture content essential for development of epiphytotics of the disease. Crop rotation played an important role in the development of the disease as was evident from the fields in which tomato crop was taken year after year showing 45.2 and 61.2 per cent disease incidence in second and third year as compared to 18.2 per cent during the first year. Nitrogen application to the soil increased disease incidence. Potash had little effect either way. Phosphorus reduced the disease slightly at higher doses only.

Sporangia were produced throughout the day and night but their production was more during morning and evening time. Relative humidity at saturation (100 per cent) was optimum for their production. Even a slight fall in relative humidity greatly reduced the production of sporangia. Germination of sporangia was favoured by free water. A correlation of disease incidence with meteorological factors showed that the disease incidence varied directly with rainfall. Temperature though important was of lesser consequence as it remained favourable for disease development during the months of June to August, the period of heavy disease incidence. An attempt was made at short term forecasting based on weekly meteorological data. A mean temperature of not less than 20°C, with an optimum in between 22°-25°C was found suitable for disease development. At lower temperatures the requirements of rainfall were higher than at higher temperatures for the causation of the disease, e.g., it required a cumulative rainfall of 150 mm. per
week for the initiation of infection at 21°C, though only 20 mm. was required at 22.5°C for it. It was also observed that disease was not serious before 20th June each year and it was suggested that third week of June may be ascribed as the zero date for the appearance of the disease.

The fungus was found to be internally seed borne. A study on host range of the fungus revealed that eight different host plants viz., Tagetes minor, Euphorbia hypericifolia, Physalis minima, Mirabilis jalapa, Commelina obliqua, Ipomoea muricata, Galinsoga parviflora and Cynoglossum wallichii belonging to different families were attacked by the fungus on artificial inoculation but none of these was found affected in nature. Of these, except for Tagetes minor all are new host records of the fungus. The fungus mycelium could remain viable in the soil for about two years under ordinary conditions and for more than two years under wet conditions in the field.

A collection of 290 tomato varieties was screened for resistance to the disease, of which 10 tomato varieties, viz., Molokai, San Marzana, and Tatinter (Australia), Money Maker 56063 (Holland), 11-149 (Turkey), Kopiah Pq x 45727 and Red Cherry (U.S.A.), a selection of Early Market (Lalbagh, Bangalore), and Chaaba Exb.64 and Flat Large Red (Himachal Pradesh) were found to be highly resistant. For finding out the factors responsible for disease resistance, average height of plants, total acidity, total ascorbic acid and total nitrogen contents of green fruits of 38 tomato varieties were calculated. Though there was a significant negative correlation between average height of plants of a given variety to disease incidence yet the regression analysis showed that none of
the factors mentioned above independently had any effect on disease incidence. Multiple correlation of the above factors with disease incidence was, however, found to be significant and multiple regression equation for predicting disease incidence in a particular variety with corresponding figures of average height of plants, per cent ascorbic acid, per cent total acidity and per cent nitrogen content was fitted.

The control of the disease against both damping-off and fruit rot phases was found. Out of 7 soil and 7 seed treatments tried for the control of damping-off, drenching the soil with Bordeaux mixture 4:4:50 or 0.2 per cent Dikar was found best, followed by soil drench with Dithane M-45 (0.2%), Cheshunt compound (1.25%) and seed treatment with Captan in the ratio of 1:400.

For the control of fruit rot phase of the disease with cultural practices, the treatments of removal of foliage and fruits upto a height of 30 cm. and 15 cm. from ground level were found best in controlling the disease, followed by staking plus mulching and staking alone. However, treatment of staking plus mulching gave the highest yield followed by removal of foliage and fruits upto a height of 30 cm. and 15 cm., respectively.

Control of the fruit rot was also tried with 10 different fungicidal sprays given at weekly intervals and out of these Bordeaux mixture 4:2:50 was the best, followed by Bordeaux mixture 4:4:50, Blitox 0.3%, Dithane M-45 0.2%, Zincop 0.25%, Fycol 8E 0.3% and Dithane 2-78, 0.2%. However, best yield was obtained with Dithane M-45, followed by Bordeaux mixture 4:4:50, Blitox and Zincop. The rest of the treatments did not show significant
differences in yield from that of control. In order to find out the reason for increased yields, total number of fruits borne and weight of individual fruits in each treatment were taken. It was observed that though variations in both the above factors did exist among different treatments but the differences were not significant. Calculating the economics, spraying the crop with Dithane M-45 was found to be most economical giving a net profit of Rs.10,240.00 per hectare, followed by Bordeaux mixture 4:1:50, Zincop, Blitox, Fycol 8E, Bordeaux mixture 4:2:50, and Dithane Z-78 with a profit of Rs.7650, 6090, 6000, 5200, 4660 and 4290, respectively. Spraying with Aureofungin and Streptocycline did not give any control of the disease.