

STUDIES ON LATE LEAF SPOT OF GROUNDNUT CAUSED BY
Phaeoisariopsis personata (BERK. AND CURT.) V. ARX.

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NOVEMBER, 1992

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STUDIES ON LATE LEAF SPOT OF GROUNDNUT CAUSED BY
Phaeoisariopsis personata (BERK. AND CURT.) V. ARX.

Thesis Submitted to the
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in
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By
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C E R T I F I C A T E

This is to certify that the thesis entitled "**STUDIES ON LATE LEAF SPOT OF GROUNDNUT CAUSED BY Phaeoisariopsis personata (Berk. and Curt.) V. Arx.**" submitted by **Mr. SUDHEENDRA. A. ASHTAPUTRE**, for the degree of **MASTER OF SCIENCE (AGRICULTURE) IN PLANT PATHOLOGY**, of the University of Agricultural Sciences, Dharwad, is a record of research work carried out by him during the period of his study in this University, under my guidance and supervision and the thesis has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar titles.

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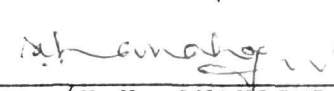
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Dedicated To
My Beloved Parents
Sri. Anantrao P. Ashtaputre
and
Smt. Prema A. Ashtaputre

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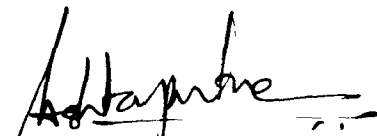
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CHAPTER - I

INTRODUCTION

I INTRODUCTION

India is one of the biggest growers of oilseeds in the world with an area of 18.00 m. ha. The production of oilseeds reached a record level of 17.80 m. tons during 1988-89.

oilseeds in the economy of Indian Agriculture are of paramount importance and considered as second major crop group occupying 11 per cent of the total cropped area contributing about six per cent to gross national product and nine per cent to total value of all agricultural commodities (Anon., 1991).

India is one of the leading oilseeds producing countries in the world, being perhaps the only country in the world having the largest number of oil producing crops viz., groundnut, sunflower, safflower, soybean, sesame, linseed, castor, niger, cotton seed and number of minor oilseeds of tree origin. Karnataka is one of the five important oilseed producing states in the country with an area of 18 lakh ha. (about 10 per cent of total area in the country) contributing about 11 per cent to the total production of oilseeds in the country. (Anon., 1991).

The cultivated groundnut Arachis hypogaea L. a native of South America is now grown throughout the tropical and warm temperate regions of the world. World wide, it occupies an area of 18.15 m. ha. with a production of 20.10 m. tons and average yield being 1108 kg per ha. (Anon., 1987). The bulk of the production comes from Asia (12.78 m. tons).

India ranks first in the world in area under groundnut 7.64 mha. and with a production of 7.30 m. tons. However, it ranks tenth in productivity (957 kg/ha). But yields are extremely poor averaging around 600-900 kg per ha., compared to yields of approximately 2500 kg per ha. in the developed countries. Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamilnadu are the five states which account for nearly 80 per cent of the area under groundnut. Groundnut is the leading oilseed crop of India occupying nearly 45 per cent of the total area under major oilseeds and contribute about 95 per cent of total major oilseed production. Therefore, the edible oil economy of the country is primarily dependent upon groundnut (Anon., 1989).

In Karnataka, groundnut occupies an area of 12.55 lakh ha. (56.50 per cent of total oilseed area) with a production of 10.64 lakh tons (72.80 per cent of total oilseed production) (Anon., 1989).

Groundnut crop suffers from many diseases caused by fungi, bacteria, viruses and non-parasitic diseases etc. Among the fungal diseases, rust (Puccinia arachidis Speq.), leaf spots (Cercospora arachidicola Hori and Phaeoisariopsis personata (Berk. and Curt.) V. Arx are more prevalent and also destructive ones.

Leaf spots are the most serious diseases of groundnut on a world wide scale. The two fungi commonly involved are

Cercospora arachidicola Hori causing early leaf spot and Phaeoisariopsis personata (Bark. and Curt.) V. Arx. causing late leaf spot.

The leaf spot disease is also called by names as Mycosphaerella leaf spots, Cercospora leaf spots, brown leaf spots, Peanut cercosporiosis, viruela and tikha. Leaf spots damage the plant by reducing the available photosynthetic area by lesion formation and by stimulating leaflet abscission. World-wide, yield losses range from 10 to over 50 per cent but vary considerably from place to place and between seasons. (Mc Donald et al., 1985).

Bunting et al., (1974) estimated that early and late leaf spots alone cause the loss of about 3 m. tons of kernels per year. Annual crop losses of 10 per cent or more are common in the groundnut growing area of the U.S.A. (Anon., 1965). Losses in yield to the extent of 20 to 25 per cent have been reported in Georgia alone, resulting in a monetary loss of 10 to 17 m. dollars annually (Miller, 1946 and Jackson and Bell, 1969). In other West African countries, about 15 to 20 per cent loss in yield of groundnut due to the disease is also being reported (Mailhac, 1931).

In India losses in yield of the crop due to the leaf spots have been estimated to be in the range of 15 to 50 per cent (Chohan, 1974, Sulaiman, 1966 and Sundaram, 1965). The combined

infection of rust (Puccinia arachidis) and leaf spots (C. arachidicola and P. perconata) cause losses to the extent of 52.65 per cent in pod yield, 27.25 per cent in 100 kernel weight and 45.76 per cent in dry matter. Leaf spot alone reduces 43.01 per cent in pod yield, 15.95 per cent in kernel weight and 31.9 per cent in dry matter weight. (Ghurye et al., 1981).

The disease is endemic in Karnataka and causes heavy loss in yield of groundnut crop, hence, survey and surveillance for the incidence of late leaf spot of groundnut are considered to be very essential. Further, the estimation of loss due to the disease is necessary, in order to emphasize the importance of the disease and control measures.

The disease becomes severe in particular period or season in a year, hence, in order to avoid the occurrence of the disease, change of date of sowing is considered as better way to escape from the disease.

The study of conidial germination of pathogen in different media is important to know the cultural characters of pathogen. The literature on germination of conidia of the pathogen in different media is lacking.

Knowledge of perpetuation of pathogen in nature important in order to determine and establish the disease cycle. This aspect of research is necessary to design the suitable control measures.

Infection by the pathogen induces changes in the chemical constituents like total phenols and total sugars which may affect the leaves. Such a study will be very useful in developing resistant varieties having particular group of chemical constituents.

Suitable control measures are necessary to combat the disease efficiently. The fungicides presently used are not satisfactorily controlling disease. Hence, the management of the disease through plant extracts and new fungicides is considered to be very essential.

Growing resistant cultivars of groundnut is being considered as the best method to manage the disease. Hence, screening of resistant varieties to manage the disease is considered to be very essential.

In India, considerable studies have been carried out on the disease or pathogen. Even then, there are still many obscure points which need thorough elucidation.

Keeping all these points in view, the following aspects of the investigation on late leaf spot of groundnut were undertaken in the present study.

1. Survey and surveillance in major groundnut growing areas of Northern Karnataka.
2. Estimation of loss in yield.

3. Influence of sowing dates on the incidence of the disease.
4. Perpetuation of the pathogen in nature.
5. Relationship of biochemical constituents in the leaf with the disease and
6. Management of the disease through non-chemicals and chemicals.

CHAPTER - II

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

The late leaf spot of groundnut caused by Phaeoisariopsis personata (Berk. and Curt.) V. Arx. is known to occur in almost all groundnut growing tracts of the world. The literature available on the incidence, severity, loss in yield, epidemiology, physiology, control and other aspects of the disease is not enough. However, in the present review, only those aspects which have a direct or indirect bearing on the aspects of the problems investigated here have been included.

SURVEY AND SURVEILLANCE OF THE DISEASE

Early and late leaf spots of groundnut have been reported throughout the world. The two diseases though they occur simultaneously in the same area, differ quite considerably in their relative severity from one region to another, depending upon the prevailing weather conditions inoculum and type of groundnut varieties grown (Gibbons, 1966).

The late leaf spot disease is more wide spread in Greece (Georgopoulos, 1958), Israel (Chorin and Mins, 1954), Japan (Katsuki, 1955), Philippines (Peyes and Tomasanta, 1940), Poldan and Juerijero, 1939), Senegal (Chevaugnon, 1952). The disease is also wide spread in Southern parts of India (Gibbons, 1979; Subrahmanyam et al., 1980). Jackson (1981) reported that, some fields in U.S.A have shown more prevalence of late leaf spots than early leaf spot.

Late leaf spot is predominant and it is particularly serious in North Kanara, Bangalore, Dharwad, Mandya and Raichur districts of Karnataka and also wide spread in Guntur, Prakasam, Nellore, Chittoor, Krishna, East Godavari, Kurnool, Nalgond and Gaddapah districts of Andhra Pradesh so also in almost all groundnut growing districts of Tamilnadu and Orissa (Subrahmanyam and Mc Donald, 1966).

From 1971 to 1981 surveys were conducted in all the major groundnut growing states in India to obtain information on rust, late leaf spot and other diseases of groundnut and also to assess their relative importance in different regions. Rust and late leaf spot diseases were the most common and severe in all major groundnut growing areas of India. (Subrahmanyam et al., 1979, Kolte, 1984).

ESTIMATION OF LOSS IN YIELD DUE TO LATE LEAF SPOT DISEASE OF GROUNDNUT

Hallamshire (1931) reported that about 15 to 20 per cent loss in yield of groundnut due to leaf spot disease in West African Countries.

Losses in yield to the extent of 20 to 25 per cent have been reported in Georgia alone, resulting in a monetary loss of 10 to 17 m. dollars annually (Miller, 1946; Jackson and Bell, 1969; Anon., 1965).

In India, losses in yield of the crop due to the leaf spots have been estimated to be in the range of 15 to 50 per cent (Sulaiman and Agashe 1965; Sulaiman, 1966; Chohan, 1974; Sundaram, 1965).

Epidemics of early leaf spot occur annually when control practices are not undertaken in the U.S.A. Annual crop losses of 10 per cent or more are common in the groundnut growing areas of the U.S.A. (Anon., 1965).

Fowler (1970) reported that, about 60 per cent reduction in yield of kernels due to the leaf spot disease in the Northern States of Nigeria.

Garren and Jackson (1973) reported that, in semi arid tropics, where chemical control is a rare measure the average loss exceeding 50 per cent is being recorded.

Cummins and Smith (1973) reported that, besides the loss in yield of kernels, the value of the hay which may be used as fodder for cattle is also adversely affected.

Bunting et al. (1974) estimated that, early and late leaf spots alone cause the loss of about 3 m. tons of kernels per year in Northern U.S.A.

Jackson and Bell (1969) estimated that, the disease is present, wherever the crop is grown and the yield losses may go up to 50 per cent.

Gerlagh and Bokdam (1973) reported that, the high incidence of disease finally results in defoliation and defoliation reduced the yields slightly, shading to a greater extent reduced pod yield by 50 per cent but had little effect on seed weight. In all treatments numerous underdeveloped pods were found. Statistical analysis shows that the net leaf surface during the 4-10 weeks before harvest can explain 50 to 60 per cent of the variation in the yield levels.

Chaje et al. (1981) estimated that, the combined infection of rust and tikka leaf spot diseases in groundnut caused losses to the tune of 27.25 per cent of 100 kernel weight, 47.76 per cent of dry matter weight and 52.65 per cent of pod yield. Losses due to leaf spot alone were 43.01 per cent in pod yield, 15.95 per cent in kernel weight and 31.93 per cent in dry matter weight.

In the absence of effective fungicides, leaf spots, frequently reduced pod yield as much as 50 per cent (Corbet et al., 1982; Shokes et al., 1983; Subrahmanyam et al., 1982). Yield losses may exceed 50 per cent if harvest of unsprayed plots is delayed and pods are abscised (Wnaft et al., 1986; Wnaft et al., 1988).

Late leaf spot is a predominant disease in Florida (U.S.A) and estimated 10 per cent of the state wide peanut production is lost every year (Kucharek, 1979).

In India, losses in yield of the crop due to leaf spots have been estimated to be in the range of 15 to 59 per cent (Ramkrishna and Apparao, 1968; Chohan and Singh, 1973; Ghewande et al., 1983).

Jayasekhar and Rajasekharan (1986) reported that, combined infection by both Puccinia arachidis Speg and Phaeoisariopsis peresata (Berk. and Curt.) V. Arx. resulted in substantial losses in yield and kernel weight. Both diseases were reduced by application of tridemorph and carbendazim.

Khashik et al. (1987) estimated that, leaf spots caused by Cercospora arachidicola Hori and Phaeoisariopsis peresata (Berk. and Curt.) V. Arx were reduced from 18.60 to 8.80 per cent. Similar trends were obtained with the susceptible cultivars viz., MH-1, J-11 and GC-60, and yield losses from these diseases were 8.0, 17.5, 18.4 and 12 per cent in the cultivars MH-2, MH-1, J-11 and GC-60 respectively.

The yield losses caused by major foliage diseases like leaf spots and rust are of the high magnitude during both the seasons of groundnut cultivation (Ghewande, 1990).

Savary et al. (1989) reported that, the combination of both early and late leaf spots can cause losses of up to 70 per cent.

EFFECT OF DIFFERENT SOWING DATES ON THE INCIDENCE OF GROUNDNUT LATE LEAF SPOT

Chevaugnon (1952) reported that, large scale sowing of groundnut should be completed as quickly as possible as the last sown fields may become severely infested. So, early sowing is better to get good yield than late sowing.

Bailey and Bridget (1966) predicted that, groundnut sown early in the season was less affected by Cercospora arachidicola Hori than late sown. Cercospora perconata (Berk. and Cust.) Ellis and Everh., occurred only on the late plantings to near harvest.

Ravindranath and Kulkarni (1967) conducted experiments during 1961, 1962 and 1963 on rainfed TMV-2 variety and observed that, as the sowing was delayed the intensity of spotting decreased. Hence, the delay in sowing decreased the disease severity but reduced the yield. The maximum disease intensity was 25.6 per cent on the crop sown on June 26 and the minimum 9.40 per cent on that sown on July 24. The yield of the crop also decreased with delay in sowing. The reason for this could be that the early sown crop had the benefit of a full season whereas the late sown crop had a shorter growth phase. These findings indicate that in a rainfed crop delay of sowing is not advantageous even though the disease could be reduced as the yield is also reduced.

Lowin et al. (1973) conducted field trial at Regional Agricultural Research Station, Tindivanam from 1969-1971 and reported that, the four earlier sowings of groundnut taken up at fortnightly intervals from 7th June to 22nd July recorded significantly lesser incidence of tikka disease and higher yields. The sowing taken up on 5th September gave the low st yield and high incidence of tikka. Both the time of sowing and tikka incidence were found to be negatively correlated with yield. Tikka incidence was found to be positively correlated with rainfall and negatively correlated with the temperature.

Shokes et al. (1982) reported that, late planting (21-23 May) resulted in a six fold increase in the number of lesions per leaflet and a decrease in yield compared with early planting (22-25 April).

Gupta (1985) reported that, early and late leaf spots are best avoided by early sowing in April when there is little inoculum present in the atmosphere. Tikka disease does not appear before 15th June and chemical control is then necessary. The early sown crop suffers least, whereas late sown crop suffers maximum, because of the high inoculum pressure in the atmosphere.

Gupta (1986) reported that, recommendations for the control of early and late leaf spots in Mandur region include early sowing (up to early April) and particularly in late sown crops and also fungicide treatment.

PERPETUATION OF THE PATHOGEN IN THE HOST PLANTS

Roldan and Guerijero (1939) reported that, the leaf spot organism survives in soil through crop residues and also organism is not seed borne and spread of spores is through wind only.

Cercospora leaf spot is less severe when the groundnuts are used in rotation than in continuous culture and pathogen overwinters in crop residues in soil and spreads to some distance by wind, insects and water currents from flooded rows. Inoculation with conidia showed that the incubation period for *Cercospora arachidicola* Hori was 7-10 days and for *C. peronosata* 12-20 days (Anon., 1943). Garren and Wilson (1931) reported that, both the pathogens survive through conidia on affected plant debris in soil or through the conidia being carried on the pod shell.

Miller (1946) reported that, the leaf spot pathogens survive best when rainfall, relative humidity and minimum and maximum temperatures are all low, but pathogens are not seed borne and seed borne inoculum is of minor importance in disease incidence.

Hemingway (1954) predicted that, *Cercospora* mycelium can persist in a dormant state for atleast six months and the undestroyed plant residues serve as a carry-over of reservoir of inoculum. Seed borne infection is of minor importance in causing the disease.

Shanta (1960) reported that, the mycelium and conidia of late leaf spot pathogen can survive in soil for a period upto 22 weeks at 40 per cent moisture.

Karunakaran and Raj (1974) have shown that, conidia have sufficient longevity to carry-over from one crop to another. Late leaf spot pathogen on groundnut survived for six weeks when infected leaves were buried 10 cm. deep in the soil. In infected leaves placed on the soil surface survival of the late leaf spot pathogen was 17 weeks.

Ramapandu and Rao (1982) have shown that, both the organisms survived in infected debris or leaflets for 75 days in the laboratory. When the leaves were deposited in soil, the fungi survived for five weeks at all moisture levels both on the surface and at a depth of 10 cm., and few lesions of Cercosporidium personatum contained viable inoculum at both the depths. In general, the survival of both pathogens was better at 25 per cent moisture and 10 cm. depth.

Conidia are produced directly from mycelium in crop debris in the soil following early rains and when deposited on the leaves of young groundnut plants by rain splash and wind and they initiate the disease cycle (Mc Donald et al., 1985).

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BIOCHEMICAL STUDIES

Purkayastha and Mukherji (1967) have shown that, both total sugar and total nitrogen contents of diseased leaves have increased by about 24 per cent and 26 per cent respectively in relation to healthy leaves.

Brahmachari and Kolta (1983) reported that, the resistant varieties showed more total phenolic compounds 21 to 25 mg. per gram dry weight as compared to susceptible varieties 15 to 16 mg. per gram at 30 days. This indicated that, the initial rate of disease development was lesser in resistant varieties compared with the susceptible varieties as the phenolic compounds are known to be antifungal to several plant pathogenic fungi. It may, however, be mentioned that, after 45 days of plant growth resistant varieties showed rather a decrease in total phenolic compounds which suggests that the initial amount of phenolic content in response to infection did not increase and therefore at later stages of plant growth the phenolic compounds appear to have no role to play in imparting the resistance.

Mohapatra (1982) reported that, leaves infected by Cercosporidium personatum contained higher quantities of reducing sugars than healthy ones. A sharp depletion in non-reducing sugars, was observed initially after infection

but later gradually arrested as the disease severity increased. Total sugar levels were increased with the disease development.

Gupta et al. (1985) reported that, phenols in leaves as one of the factors for disease resistance, their presence in higher levels on the leaf surface of the resistant variety MH_2 , may be responsible for its resistance to tikka disease. The concentration of both reducing sugars and soluble nitrogen was higher in the susceptible variety MH_1 as compared to the resistant variety MH_2 . Thus, it appeared that, the presence of reducing sugars and soluble nitrogen on leaf surface favoured the penetration and establishment of the pathogen, while waxes and phenols offered resistance.

Sindhan et al. (1987) have shown that, the levels of total phenols, orthodihydroxy phenols and reducing sugars were higher in the resistant cultivars M-147, G-201 and M-13 to tikka disease and the levels of total sugars lower than those in susceptible cultivars JL-24, MH_1 and AK-12-24.

Sindhan and Jaglan (1988) predicted that, carbendazim (Derozal), carbendazim (Zevistin), benomyl (Benlate), thiophanate methyl (Topsin M) and mancozeb (Dithane-M-45) controlled both the leaf spots of groundnut by enhancing plant resistance through an increase in total phenol and potash with decrease in sugars and phosphorus contents of treated groundnut plants.

Kaur and Phillon (1990) reported that, late leaf spot of groundnut caused a decrease in total chlorophyll, sugar and starch but the protein content increased considerably. Susceptible cultivars showed a rapid decrease of sugars and starch but the decrease was relatively slow in resistant cultivars. The alterations in protein content were less in resistant cultivars.

SCREENING OF RESISTANT VARIETIES

Chahal and Pandhu (1972) conducted experiment with 58 field resistant groundnut varieties against Cercosporidium personatum and Cercospora arachidicola under artificial epiphytotic conditions during Kharif, 1971 and data revealed that 12 varieties were resistant, 23 tolerant and 23 susceptible to the above pathogens.

Abdou et al. (1974) reported that, only minor variations in the resistance were found among groundnut cultivars but sources of resistance occurred among wild species of the seven taxonomic sections of the genus tested. Arachis charys was highly resistant to A. arachidis and A. conglutinata appeared immune to A. baharensis. Resistance in leaves was associated with the formation of a barrier in advance of and around the infection site and pectic substances were deposited on the cell walls and in intercellular spaces.

Sutrahmanyam et al. (1983) screened 23 groundnut germplasm lines and evaluated against rust and tikka diseases. Among these, nine were resistant to P. arachidis and six of these (PI 1259747, PI 350880, PI 381622, PI 405132, PI 219886 and PI 341879) were also resistant to M. berkeleyi and could prove useful in breeding for multiple disease resistance.

Krishnaprasad et al. (1979) have shown that, bunch varieties viz., JH-8-18, C-501, HYG-13-3-18, T-98 and HC-21011 a semi spreading variety showed good resistance recording a disease index below 1.60, while S-206 recorded 3.596 and 4.882 during 1975 and 1976 respectively.

Ghewande et al. (1983) identified promising sources of resistance to P. arachidis and C. parasitum from 3655 entries screened during 1980, 1981 and 1982 only B-613 and PI 341839 were resistant to both the diseases.

Patil et al. (1984) reported that, among 250 varieties, 14 cultivars were found to be resistant to late leaf spot, but none of them showed resistance to rust.

Gupta (1987) reported that, only 21 of 253 groundnut cultivars screened in the field were resistant to C. arachidicola and C. parasitum.

Chitka et al. (1988) reported that, a total of 116 groundnut genotypes which included all market types was

evaluated to late leaf spot in two green house and one field test on the basis of lesion number per leaf, per cent leaf necrotic area, lesion diameter, spore production and latent period. Amount of sporulation, lesion size and latent period were highly correlated with each other and also with per cent leaf area affected.

Joyloy et al. (1987) reported that, twenty groundnut population in P_2 generation from an $M \times N$ mating design involving five C. rostratum resistant female parents and four adopted male parents were evaluated for late leaf spot resistance with a detached leaf culture technique. Of the male parents NC-6 and NC-7 produced the best progenies for both agronomic traits and late leaf spot resistant NC-17090 produced the best progenies for pod yield and seed yield NC-17135 produced progenies with good agronomic traits. Correlation among components of resistance to late leaf spot indicated that, lines with increased latent period, decreased lesion number, lesion size and defoliation and reduced spore production can be selected. Selection for late leaf spot resistance in the P_2 population was not effective.

Chaudhary (1988) reported that, of 55 the non-spreading and 45 spreading genotypes of Arachis hypogaea L. evaluated in the mid altitude conditions of Meghalaya during 1985-87, five non-spreading genotypes (NRCG accessions 512, 580, 4415, 4632 and 5953) and two spreading genotypes (NRCG 76 and NRCG 6428) were rated resistant to Myconopharella perkeleyii. However, there were more moderately susceptible spreading genotypes than non-spreading ones.

Moraes et al. (1988) reported that, in the field epidemics of C. personatum infection started 60-70 days after planting in Brazil. Genotypes SO-850 and SO-909 were the most resistant with the lowest values of infection index area under the disease progress curve and apparent infection rate. Lesions were small and atypical with scanty sporulation. The long cycle genotypes S070, Macro, S0464, S0407, S0405, S05237, S05239 and S05241 were moderately resistant to the disease.

Jayasekhar et al. (1989) observed that, NCAC 17135, NC 76446, ICG 17, ICG 18, ICG 11, PI 259747 and APNDS 20 groundnut genotypes were found to be resistant to late leaf spot.

Soriano (1988) conducted experiment to study the resistance to leaf spot of groundnut and observed that, dormant seeds of groundnut were irradiated with 10-40 KR and also subjected to pre and post irradiation treatments (unspecified) to minimise radiation damage. The first two leaves of M_2 seedlings were inoculated two or three times in the field at one week intervals with spores of C. arachidicola (M. arachidis) and C. personatum (M. herkeleyii). Of 2453 M_2 seedlings inoculated thrice, observed, nine plants showed complete resistance. However, after recurrent selection, only three M_2 lines were completely resistant, while others showed intermediate resistance. The disease resistant lines yielded almost twice as much as several

commercial varieties owing to severe defoliation in the latter. Inheritance studies indicated that resistance is controlled by two complementary recessive mutant genes.

Mattyal and Bailey (1988) evaluated modifications of the advisory programme for control of C. arachidicola (M. arachidis), C. personatum (M. berkeleyi) in six groundnut genotypes in three field experiments in North Carolina during 1985 and 1986. Relative humidity-temperature index values from the Jensen and Boyle model were modified by factors of 0.85 and 0.70. The average number of fungicide applications were 7.0, 5.3, 4.0 and 2.6 for the 14 days schedule, standard advisory, 0.85 modified advisory and 0.70 modified advisory treatments respectively. Results indicated that, either advisory modifications could be used with leaf spot resistant genotypes NC-5, NCOP 343 x NC 5 (Entry 86) and NC-6 without resulting in significantly greater area under disease progress curves (AUDPCs), area under defoliation curves (AUDEFCs) and infection rates than the non-modified advisory. However, comparisons across all genotypes and locations indicated that, the modified advisories resulted in significantly larger AUDPCs, AUDEFCs and apparent infection rates but no significant reduction in yield. Yield loss models had indicated, that the genotypes had similar yield responses to leaf spot.

Chitaka et al. (1988) discussed about the components of resistance to late leaf spot caused by C. personatum. Significant

difference in spore incubation period, latent period, lesion number per leaf, percentage leaf necrotic area, lesion size and the amount of sporulation were observed for each component. The greatest variability among genotypes had smaller lesions, longer periods and reduced sporulation.

Shen et al. (1989) studied components of partial resistance in peanut genotypes to isolates of C. personatum from United States and Thailand. They observed that, Thai isolates generally caused more lesions than US isolates on all genotypes. Differences among isolates for other disease components were small and varied between two trials. Stability of resistance to several disease components was evaluated with regression analysis in which low mean disease ratings, non-significant deviations and slopes near zero in the regression indicated stable resistance. Few significant deviations which indicate significantly higher disease in specific isolate X genotype combinations, were found among moderately and highly resistant genotypes.

MANAGEMENT OF THE LATE LEAF SPOT OF GROUNDNUT THROUGH NON-CHEMICALS AND CHEMICALS

Miller (1942) reported that, three applications, of sulphur dust at fortnightly intervals on 30 farms increased the average yield by 481 lb/ac.

Shaw and Habert (1941) reported that, copper sulphate and copper sprays controlled both leaf spot diseases of groundnut. Wilson (1950) observed that groundnut seeds although carry inoculum of C. parasitatum, but there is no evidence that seed borne inoculum can cause the disease. So, seed treatment does not satisfactorily control the disease.

Mahes et al. (1953) reported that, the incidence of groundnut leaf spots in Uttar Pradesh was greatly reduced by sulphur dusting (16 lb/ac), resulting in 40 per cent yield increase with rounds at 10 days intervals and 30 per cent at 15 days. Similarly, sprays of Bordeaux mixture (2:2:50), Perenox (0.15 per cent) and Cuprevit (0.15 per cent) at 15 days intervals gave increase of 15 per cent, 20 per cent and 30 per cent respectively in late maturing varieties.

Although C. parasitatum and C. arachidicola are reduced by lime-sulphur or copper fungicides or dusting with sulphur but it is not economic. The yield of variety Multunde was related to the number of wet days in December-February following planting. Dithiocarbonates tested were ineffective against the pathogens. (Corbet and Brown, 1966).

Mercer (1973) described the most effective and economical uses of fungicidal dusts and water based sprays to control the diseases. He conducted experiment and observed that high yields were obtained with Bavistin and NP-48 both systemic and structurally related to benomyl. Benomyl itself

gave disappointing results. Of the other water based sprays, chlorothalonil was used successfully in several seasons and both copper hydroxide and fentin hydroxide were found to be effective. Copper and sulphur dusts have given good results for a number of years although not always giving the highest yields.

Narain and Sathyanthy (1977) have shown that, leaf, flower, stem and root extracts of two varieties of Vigna mungo L were antifungal to Helminthosporium nodulicorum Berk. and Curt., Sclerotium rolfsii Sacc., Pestalotia de Not., Fusicarium gossyporum emend Sny. and Hana., Colletotrichum Corda and Aspergillus niger Van Tieghem., which parasitise raji, green gram, brinjal, tobacco and groundnut respectively. The extracts inhibited the spore germination and mycelial growth of the test fungi. The extracts markedly differed in their fungitoxic activity. Studies revealed that, leaf extracts were generally more antifungal than the extracts from flower, stem and root.

Radhakrishnan et al. (1977) conducted field trials during 1973 and 1974 and the best control of groundnut rust (P. arachidis) was obtained by chlorothalonil (Daconil) and mancozeb (Dithane M-45). The latter fungicide was most promising.

Narain et al. (1981) have shown that, in field tests with eight seed treatment, against C. personatum, C. arachidicola the disease intensity was least with Bavistin + TMTD, whereas

Vinosa rosea leaf extract gave some control and increased the yield also.

Kolte et al. (1978) reported that, Bavistin, Benlate, Cercobin M showed excellent degree of disease control as compared to protective fungicides such as Duter, Dithane M-45, Dithane Z-78 and Kocide. Duter was, however, found superior to Dithane M-45, Dithane Z-78 and Kocide.

Siddaramiah et al. (1980) have reported that, the spore germination of tikka and rust was completely inhibited by garlic extract at a concentration of 1:8, while Alternaria spores were inhibited at 1:7 concentration followed by ginger extract at 1:5 and onion extract at 1:3 concentration, but turmeric was ineffective. Garlic extract suppressed the infection of all the three diseases under field conditions.

Sekhon and Dhillon (1981) conducted experiments for the control of tikka disease of groundnut with Benlate, Bavistin, Difolatan, Sulphur W.P., Dithane M-45 and Macuprex during 1975 and 1976. During 1977 Daconil, Dithane Z-78, Dithane M-45 + Bavistin and Daconil + Bavistin were added. Benlate, Bavistin and Daconil were the effective fungicides for the control of tikka disease of groundnut. The optimum dose of Bavistin was found to be 150 g. in 250 ltr. of water per hectare for one application. Four sprays starting from 30 days after sowing at fortnightly intervals increased groundnut pod yield substantially.

Ponniah et al. (1982) observed bitertanol (Baycor) controlled both leaf spot and rust disease of groundnut. Sataraajan and Subramanian (1983) tested 17 fungicides under field conditions over three years against P. arachidis, M. arachidis and M. oryzae. Bitertanol (Baycor) performed better against rust giving higher yields and carbendazim (Bavistin) against leaf spot. A combined spray is recommended when both diseases occur together in a particular locality and season.

Pattan and Kang (1982) reported that, Bavistin and Benomyl effectively controlled tilda and increased the vegetative growth, chlorophyll content, shelling percentage, kernel weight and oil content yields were 67.70 and 66.80 per cent higher in Bavistin and Benomyl treated plants respectively, while plants treated with non-systemic fungicides yielded 41.90 per cent more pods than controls. Maximum increase in oil percentage occurred in Bavistin treated plants.

Lande et al. (1983) reported that, chlorothalonil controlled P. arachidis, C. arachidicola, and C. personatum effectively.

Lalithakumar et al. (1984) reported that, among the fungicides tested against leaf spot, Baycor gave excellent control of the disease.

Five sprays of carbendazim (0.05%) + mancozeb (0.2%) at 15 days interval were the best for the control of leaf spots in the late sown crop of Manipur (Gupta, 1985).

Shankar *et al.* (1985) reported that, the spray schedule consisting two sprays of mancozeb (0.2%) at 35 and 70 days after germination and one spray of carbendazim (0.25%) at 60 days after germination was most economical with a ICR of 1:2:85 and thus found suitable for its recommendation to the farmers of northern Saurashtra.

Marlotto (1985) observed that, an isolate of *M. oryzae* from groundnuts in the Herculanis area, where benomyl and carbendazim treatments had lost effectiveness, grew on oat meal agar containing 100 ppm benomyl, while an isolate from another area was inhibited when the medium contained more than one ppm.

Vyas *et al.* (1986) recommended that, carbendazim (0.075%) + mancozeb (0.15%) mixture should be sprayed around August 15 which is susceptible stage of the crop for both leaf spots and rust diseases and second and third spray would be repeated depending on the intensity of these diseases.

The rust and leaf spots were substantially reduced due to the application of carbendazim (0.025%) + tridemorph (0.04%) five times at fortnightly intervals commencing from 35 days after sowing during summer season (Jayasekhar and Rajasekharan, 1986).

The leaf spots and rust are controlled effectively by application of carbendazim (0.05%) + mancozeb (0.2%) at 2-3 weeks interval, 2 or 3 times starting from 4-5 weeks after planting and gave the highest cost benefit ratio ranging from 1:14.8 to 1:24.4 (Anon., 1981).

Vidhyasekaran (1981) reported that, Daconil, Duter and Dithane M-45 controlled the rust, while Bavistin, Daconil and Duter controlled tikka disease.

Chuge et al. (1981) reported that tridemorph at the rate of 0.07 per cent spray and carbendazim at the rate of 0.05 per cent spray inhibited the development of rust and tikka leaf spots, respectively.

Gerlach et al. (1986) evaluated six fungicides and found best control of the rust and late leaf spot of groundnut was noticed with bitertanol (Baycor) and chlorothalonil (Bravo 500 F) and obtained almost double yields.

Cairos et al. (1987) reported that, chlorothalonil controlled both early and late leaf spots of groundnut in field.

Thekore et al. (1987) evaluated twelve fungicides in vivo and in vitro and Bitertanol controlled early and late leaf spots as well as rust and increased the yields considerably.

Godare and Thakore (1987) observed in plot trials, one or two sprays with triadimefon and triadimenol at 0.1 to 0.2 per cent reduced infection of C. personatum (M. berkeleyi).

C. arachidicola (M. arachidis) and P. arachidis and resulted in higher yields. Triadimefon was absorbed faster but both fungicides could be detected in leaves 12 hours after soil application using Macrophoma phaseolina (Tassi) Gold as test fungus. The fungicides were amphimobile, when applied to soil and they persisted in leaves and roots for 28 days, while as foliar sprays they could be detected in leaves and roots for 35 days.

Gupta et al. (1987) reported that, unsprayed plants with a disease incidence of 43.73 per cent showed reduction in the oil and iodine contents were elevated. Maximum disease control was obtained with thiophanate methyl.

Sumner and Littrell (1989) reported that, chlorothalonil and diniconazole were applied to groundnut in microplots through irrigation water with hand sprinklers or by conventional sprays for control of leaf spots. Foliage disease caused by Cercosporidium personatum and the number of lesions on pods, pegs and stems were usually reduced by treatments.

Brenneman and Sumner (1989) reported that, application of foliar 7 times was found effective against late leaf spot.

Ghevanis (1989) reported that GAD3-1 was treated with aqueous leaf extracts of Asadirachta indica A. Juss., Lamsonia inermis Lamk., Tridax procumbens L. and Pongamia pinnata Vent and fungicides MCP-75 (0.3%) and carbendazim (0.05%) + mancozeb (0.2%). The incidence of Phaeoisariopsis personata and Puccinia arachidis was recorded 15 days before harvest. Carbendazim + mancozeb gave maximum control of P. arachidis and P. herhelovii. Asadirachta indica and Lamsonia inermis extracts were effective in controlling both the diseases and yields increased by 15.43 to 39.84 per cent due to treatment and the maximum increase was with the chemical treatment.

Kannaiyan and Hacia (1990) reported that, 2-3 replications of benomyl, chlorothalonil or thiophanate methyl + maneb are sufficient to minimize the severity of leaf spot disease of groundnut.

CHAPTER - III

MATERIAL AND METHODS

III MATERIAL AND METHODS

The present investigation was undertaken during Kharif 1991 at the Main Research Station, University of Agricultural Sciences, Dharwad. Dharwad is situated in the transitional tract of Karnataka at 15° 26' north latitude and 75° 07' east longitude at an altitude of 678 m. above m.s.l.

The mean annual rainfall of Dharwad area is about 825 mm distributed over a period of seven to eight months (April to November) with two prominent peaks occurring in July and October. The months of March, April and May are the hottest with mean maximum temperature between the range of 33° to 37°C. December and January are the coolest months with mean minimum temperature upto 11°C. The relative humidity fluctuates between 40 and 85 per cent. The details of the materials used and the methodology adopted during the course of this investigation are given here under.

SURVEY AND SURVEILLANCE FOR THE INCIDENCE OF GROUNDNUT LATE LEAF SPOT DURING KHARIF, 1991

Groundnut is one of the main Kharif crops of Northern Karnataka and grown under both rainfed and irrigated conditions. An intensive survey was conducted during September/October, 1991 on the incidence and severity of the late leaf spot disease in groundnut growing areas. Groundnut fields of three talukas of

Belgaum (Saundatti, Bailhongal, Ramdurg), two of Dharwad (Dharwad, Hubli) districts were surveyed. The late leaf spot severity was recorded by following the nine point scale (Sathyanarayana *et al.*, 1982).

In each taluk, three villages were selected for survey and in each village five fields were selected. In each field five plants were selected randomly and scored for the disease incidence by following nine point scale. Stage of the crop and variety grown were also recorded.

ESTIMATION OF YIELD LOSSES DUE TO LATE LEAF SPOT OF GROUNDNUT

A field experiment was conducted during Kharif 1991 at the Main Research Station of University of Agricultural Sciences, Dharwad. Losses due to late leaf spot were estimated under conditions by using effective fungicide like chlorothalonil (Kavach) to control late leaf spot. Groundnut variety JL-24 was grown under standard grower's practices with a plot size of 3 x 3 m. Seven treatments consisting of spray application of chlorothalonil (0.2 per cent) and one water spray control were arranged in a randomised block design with three replications.

The fungicide chlorothalonil (0.2 per cent) was sprayed at an interval of five days in each of the three replications and in all six sprayings were given. The fungicide was given soon after the appearance of the disease. Different number of chlorothalonil sprays were given to each plot i.e., first

spray of chlorothalonil (Kavach 0.2 per cent) was given immediately after the onset of the disease to all the plots in all replications, except control plots which were kept unsprayed throughout. Second spray of chlorothalonil was given after five days of first spray, to all the plots leaving first plot in all the replications and subsequent sprayings were given at five days interval leaving subsequent plots. So first plot was given only one spray of chlorothalonil, second plot was given two sprays of chlorothalonil and so on and so forth and sixth plot was given six sprays of chlorothalonil and similarly control plot in each replication was kept unsprayed. The disease intensity and pod yield per plot were recorded later.

EFFECT OF DATE OF SOWING ON THE INCIDENCE OF LATE LEAF SPOT OF GROUNDNUT

A field experiment was conducted during kharif, 1991-92 at the Main Research Station, University of Agricultural Sciences, Dharwad to know the occurrence of late leaf spot in the field. The groundnut varieties viz., Dh-330, JL-24 and TMV-2 were used in the study and four sowings were done with fifteen days interval.

Design	: Split Plot Design
Net plot size	: 5 m x 3 m.

Replications : Three
 Sowing dates : Four
 Varieties : Three

The severity of the disease was recorded as per the scale given by Subrahmanyam *et al.* (1982). The response was recorded by using the following scale. (Fig. 1).

<u>Score</u>	<u>Infection type</u>	<u>Per cent damage</u>
1	No disease.	0.0
2	A few, small necrotic spots on older leaves.	0.5
3	Small spots, mainly on older leaves, sparse sporulation.	1.0
4	Many spots, mostly on lower and middle leaves, disease evident.	2.0
5	Spots easily seen on lower and middle leaves, moderately sporulating yellowing and defoliation of some lower leaves.	5.0
6	As rating of five but spots heavily sporulating.	10.0
7	Disease easily seen from a distance, spots present all over the plant, lower and middle leaves defoliating.	20.0
8	As rating of seven, but defoliation is more severe.	35.0
9	Plants severely affected, 50-100% defoliation.	50.0

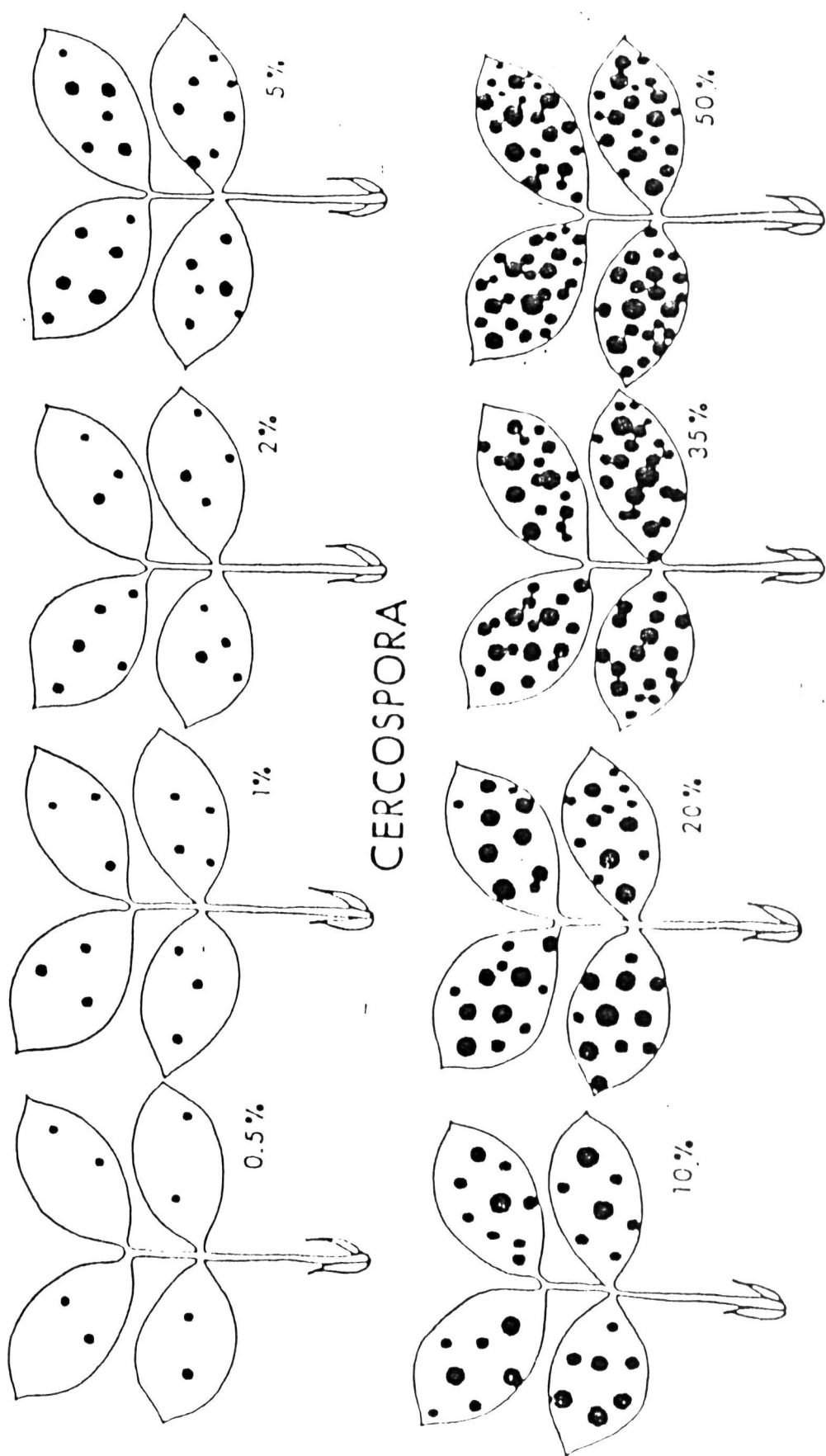


FIG. 1. SCALE FOR ESTIMATING SEVERITY OF LATE LEAF SPOT OF GROUNDNUT.

The severity of the disease was recorded as disease score at 50, 57, 65, 72, 80 and 87 days after sowing. Since the severity of the disease was expressed in percentage, the angular transformation was carried out before taking up the statistical analysis.

The data pertaining Per cent Disease Index (PDI) at 50, 57, 65, 72, 80 and 87 days after sowing and yield at harvest were subjected to statistical analysis under split plot design.

To know the effect of date of sowing and PDI on the yield, a regression model of the form $Y_{ijk} = \mu + b_1d_i + b_2(PDI)_j + E_{ijk}$ was formulated where Y_{ijk} is the yield of 'k' th plot with 'i' th date of sowing and 'j' th level of PDI. d_i is the effect of 'i' th date of sowing. $i = 1, 2, 3$ and 4 . $(PDI)_j$ is 'j' th level of per cent disease index. E_{ijk} is the error associated with the yield of 'k' th plot with 'i' th date of sowing having 'j' th level of per cent disease index and μ , b_1 and b_2 are the parameters of the regression model.

The values of μ , b_1 and b_2 were estimated by the method of least square given in Draper and Smith.

CONIDIAL GERMINATION OF Phaeoisariopsis versatilis IN DIFFERENT MEDIA

To obtain or promote maximum germination of conidia,

conidia of Phaeoaeariopsis personata were collected just by scraping lesion surface with clean stainless blade. These conidia were collected from a groundnut variety JL-24. Uniform suspension of conidia was prepared in different liquid media viz., tap water, and one and two per cent glucose, sucrose, maltose and lactose solutions separately. The prepared suspension was sprinkled on clean glass slides, which were kept in the Petridishes lined with moist blotting paper and then incubated at room temperature ($27 \pm 1^\circ\text{C}$) at different time intervals. The germination percentage was recorded after 6, 9, 12, 15, 18, 21 and 24 hours of incubation. Proper care was taken to see that, not more than 10 to 15 minutes lapsed between preparation of suspension and incubation. On each slide, three drops of suspension were placed and they were replicated twice. Conidia with the germ tubes longer than their diameter were considered as germinated, and then per cent germination was worked out.

STUDIES ON PERPETUATION OF PATHOGEN IN THE HOST DEERIS

As a part of epidemiological studies, the survival of the pathogen was studied during kharif, 1991. Groundnut leaves heavily infected with the pathogen (P. personata) were collected and divided into four lots. One lot was preserved in a refrigerator at 6°C , second lot was under laboratory conditions ($21-27^\circ\text{C}$), third lot in glass house and fourth was kept in the

open field, to expose them to varied atmospheric temperature and conditions. This lot was protected from rains in monsoon months.

Conidia were collected from such preserved debris at an interval of seven days and examined for their viability by observing their germination under the microscope.

BIOCHEMICAL ANALYSIS

Samples of healthy and diseased leaves of JL-24 were collected for biochemical studies.

Total sugars and total phenols were determined in the ethanol extract of leaves as per the procedure indicated by Mahadevan (1966). The details of the extraction are given here under.

The dried leaves were powdered and one gram of sample from each treatments were refluxed for 30 minutes in 25 ml. of 80 per cent distilled ethanol on hot water bath. The supernatant extract was decanted into another flask. The residue was again re-extracted with small quantity of ethanol and decanted. Both the extracts were mixed and filtered through Whatman No. 1 filter paper. The final volume was made up to 25 ml with ethanol extract and was used to estimate the total phenol and total sugar.

Total phenols in the ethanol extracts of leaves from various samples were estimated using Folin-Ciocalteu reagent (Bray and Thorpe, 1954). The particulars of the procedure of the estimation are given here under.

To one ml. of ethanol extract, one ml. of Folin-Ciocalteu reagent (distilled with equal quantity of water before use) and two ml. of 20 per cent sodium carbonate were added. This mixture was heated on a water bath for one minute. Later, it was diluted to 25 ml. with distilled water and the intensity of the blue colour was read at 650 nm. using spectrophotometer. Appropriate blanks were prepared which were used to adjust light transmission to 100 per cent. A calibration curve was prepared using pyrocatechol from which the quantities of total phenols as pyrocatechol were expressed in mg. per g. of leaf samples.

Estimation of total sugars

Total sugars in the aqueous extracts were estimated by following the procedure of Shields and Burnett (1960) i.e., Anthrone method.

1 ml. Aliquot of alcohol evaporated plant extract was pipetted out into test tubes. Then 4 ml. of anthrone reagent was added to each tube along the side of the tube. Then these tubes were placed in the boiling water bath for 10 minutes and allowed to cool at room temperature. The blank was treated

similarly with reagent. The absorbance of the blue green solution was measured at 625 nm in a spectrophotometer. Then the amount of total sugars present in the extract was calculated using standard curve prepared from glucose.

SCREENING OF PROMISING POUNDNET VARIETIES AGAINST LATE LEAF SPOT

Screening of promising poundnet varieties against late leaf spot caused by Phaeoannularia personata was carried out to identify the source or sources of resistance. Twelve varieties were selected for the study and each of them were planted in five rows in each plot and each variety replicated four times.

The experiment was conducted during kharif, 1991 at the Main Research Station, Dharwad. Observations were recorded after screening the varieties under natural conditions. The disease intensity was recorded at the maturity stage, using disease score as given earlier.

EFFECT OF PLANT EXTRACTS AND CHEMICALS

Four commonly available plants viz., Coconut, Borjuna, Neem and Parthenium leaves were collected and used for extracting the antifungal substances. The leaf samples were washed in tap water and also with sterile distilled water. These leaf samples were cut into pieces and then 50 g. of each of leaf pieces were collected and crushed in a sterile pestle and mortar separately. Then the extract was squeezed through sterile

muslin cloth for 2-3 times. Such filtrate was diluted upto 1500 ml. with water and used for the experiment.

Fungicides viz., chlorothalonil (Kewach) @ 0.2% , carbendazim (Bavistin) @ 0.1%, mancozeb (Dithane M-45) @ 0.2% bitertanol (Baycor) @ 0.15% along with plant extracts were used to evaluate for efficacy against the disease.

The experiment was conducted during kharif, 1991 at Main Research Station, University of Agricultural Sciences, Dharaod by using JL-24 and maintaining three replications of nine treatments (4 plant extracts and 4 chemicals and one control). Both plant extracts and fungicides were applied three times as first spraying after the incidence of the disease and subsequent sprayings at 15 days intervals and also the leaf spot incidence was recorded at 15 days interval. The disease intensity and pod yield per plot were recorded later.

CHAPTER - IV

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

The results of the investigation on the late leaf spot of groundnut caused by Phaeoglyphis gossypii are presented here under.

SURVEY AND SURVEILLANCE FOR LATE LEAF SPOT OF GROUNDNUT

Survey was conducted for late leaf spot of groundnut during Kharif, 1991, in different talukas of Dharwad and Belgaum districts, to know the severity in farmers fields (Plate I to III). The data pertaining to this study are given in table 1.

The results indicated that, the late leaf spot was very severe in Dharwad and parts of Belgaum districts. Late leaf spot incidence was moderate in talukas of Saundatti, Bailhongal and Hubli (20 to 35 per cent). In Saundatti taluk, three villages were surveyed, Chikkavilkeri (20 per cent), Nivavilkeri (20 per cent) and Inamhongal (35 per cent) and in Bailhongal taluk, villages surveyed were Kardrolli (35 per cent), Sigihalli (35 per cent) and M.K. Hubli (35 per cent disease) whereas in villages, of Hubli taluk the disease was observed in Ballarwad (35 per cent), Hekur (35 per cent) and Kimeur (35 per cent). Late leaf spot was severe in talukas of Wandarg and Dharwad (50 or more than 50 per cent disease). In Wandarg taluk, two villages were surveyed viz., Sutakarki and

Table: 1. Survey and Surveillance for late leaf spot of groundnut caused by Phaeoisariopsis personata during Kharif, 1991.

District	Taluk	Village	Variety	Stage of the crop	Incidence of the disease in per cent age
Dharwad	Dharwad	Aminbhavi	TMV-2	80 days	35
			TMV-2	80 days	50
			TMV-2	75 days	20
		Narendra	TMV-2	80 days	35
			JL -24	85 days	35
		Dharwad	TMV-2	80 days	50
			JL -24	80 days	50
			Dh 3-30	80 days	35
	Hubli	Ballerwad	TMV-2	85 days	35
			JL -24	85 days	35
		Mehsur	JL -24	80 days	35
			TMV-2	80 days	35
		Kiresur	TMV-2	80 days	35
			JL -24	75 days	20
Belgaum	Saundatti	Chikka-Ullikeri	JL -24	85 days	20
			TMV-2	85 days	20

Contd..

District	Taluk	Village	Variety	Stage of the crop	Incidence of the disease in per cent age
		Nireulli-heri	JL -24	75 days	20
			TMV-2	80 days	20
		Inamhongal	TMV-2	80 days	25
			JL 24	85 days	25
	Bailhongal	Kadrolli	TMV-2	80 days	25
			JL 24	85 days	25
		M.K.Hulli	TMV-2	85 days	25
			JL 24	85 days	25
		Sigihalli	TMV-2	85 days	25
			JL 24	80 days	20
	Rondreg	Randurg	JL 24	80 days	20
		Butakarkki	TMV-2	85 days	20
			TMV-2	80 days	20
		Goudabhevi	TMV-2	80 days	20
			TMV-2	80 days	20
			TMV-2	85 days	20

**Plate No. I. Photograph showing 10-20 per cent
leaf area affected by late leaf
spot of groundnut.**

**Plate No. II. Photograph showing 35 per cent
leaf area affected by late leaf
spot of groundnut.**

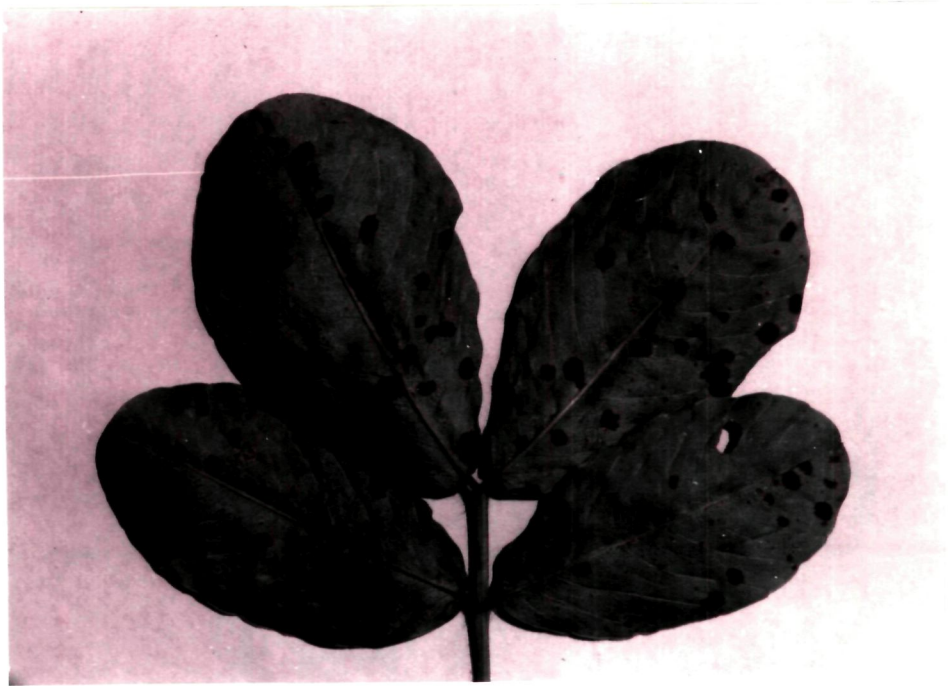


Plate No. I.



plate No. II.

**Plate No. III. Photograph showing severe infection
of late leaf spot of groundnut
(more than 50 per cent leaf area
affected).**



Plate No. III

Gondakhavi, where almost all plants in the fields were defoliated (more than 50 per cent disease) due to the disease. In general, the groundnut late leaf spot was prevalent in all the localities of both districts under report.

ESTIMATION OF YIELD LOSS DUE TO LATE LEAF SPOT OF GROUNDNUT

The field trial was conducted during kharif, 1991 at the Main Research Station, University of Agricultural Sciences, Dharwad. The fungicide chlorothalonil (0.2 per cent) was used in the study. Further, optimum number of sprays of chlorothalonil to control the late leaf spot was also worked out. The yield of groundnut was reduced substantially due to the infection of late leaf spot. From the data, presented in table 2, it is evident that, yield of groundnut was reduced in control plots or unprotected plots compared to fungicide treated plots. The disease incidence was high in control plots than fungicide treated plots (Plate IV). So there, was relationship between the incidence of disease and also yield. But, by using chlorothalonil the disease was reduced and yield was increased. There was no significant difference in infection between one spray and two sprays of chlorothalonil but disease was significantly reduced by three sprays and four sprays of chlorothalonil and again there was no significant difference in infection between four sprays, five sprays and six sprays of chlorothalonil which had showed reduced infection. The disease

Table: 2 Estimation of loss in yield due to late leaf spot of groundnut caused by Phaeoisariopsis personata.

Sl.No.	No. of sprayings of chlorothalonil	FDI at 80 DAS	Yield (kg/plot)
1	One	61.89 (77.78)	3.87
2	Two	56.11 (68.89)	5.44
3	Three	48.22 (55.56)	5.11
4	Four	35.24 (33.33)	6.30
5	Five	31.31 (27.41)	6.34
6	Six	29.98 (25.93)	6.38
7	No spray (control)	90.00 (100.00)	3.32

Figures in the parenthesis are original values

	FDI	Yield
S.E.m ±	2.07	0.34
C.D.at 5%	6.38	1.06

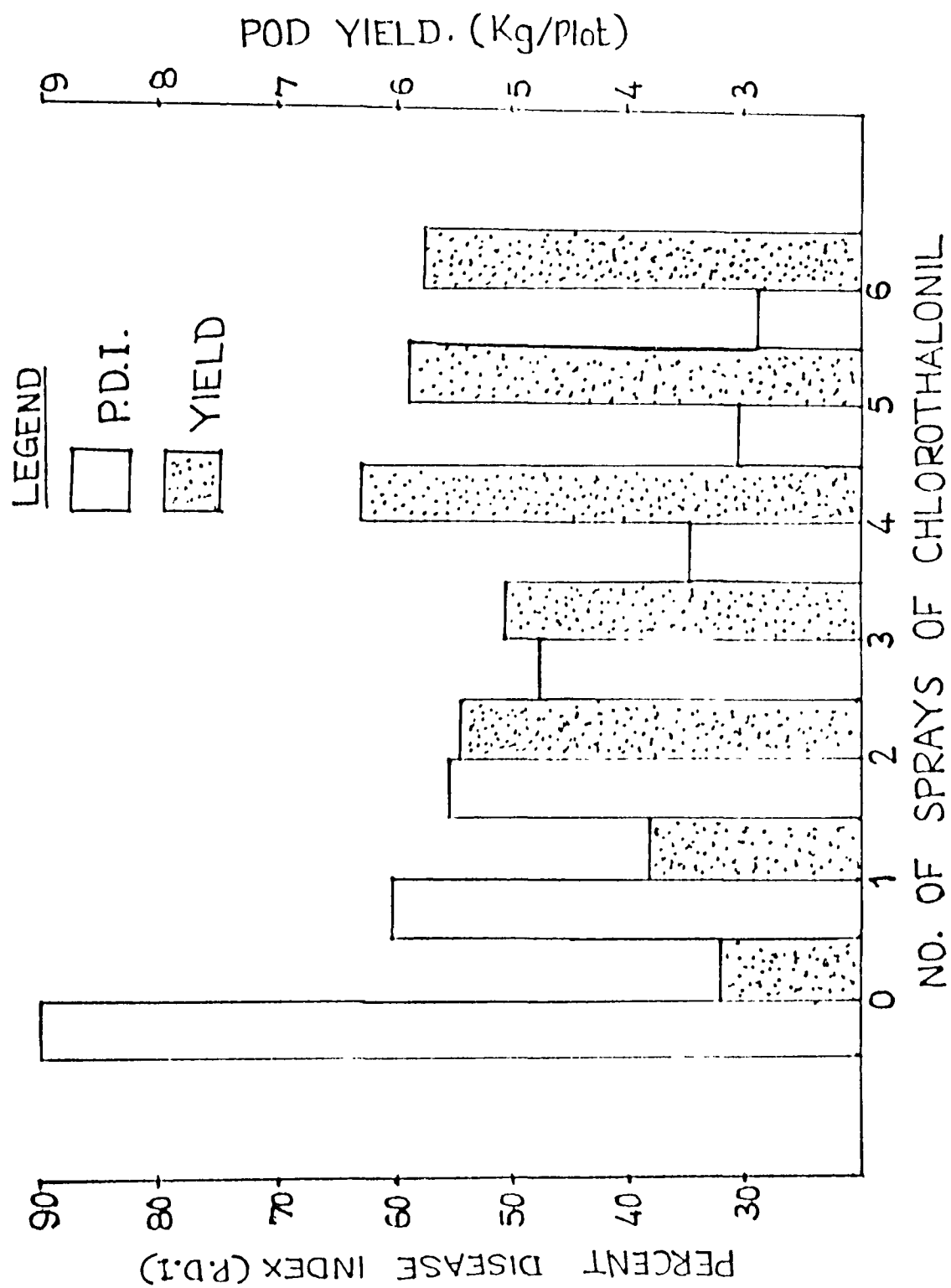


FIG.2. ESTIMATION OF YIELD LOSS DUE TO
LATE LEAF SPOT OF GROUNDNUT
CAUSED BY Phaeoisariopsis personata

Plate No. IV. Photograph showing protected and unprotected plants of groundnut.



Plate No. IV

Plate No. V. Photograph showing effect of different number of sprays of chlorothalonil in controlling of late leaf spot of groundnut.

Plate No. VI. Photograph showing effect of different number of sprays of chlorothalonil in control of late leaf spot of groundnut.



Plate No. V.



Plate No. VI.

incidence was reduced in all sprays of chlorothalonil compared to control (Plate V and VI and Fig. 2).

It is also evident from the table 2 that, yield was increased by using chlorothalonil which reduced the disease significantly. The yield was significantly higher in four sprays of chlorothalonil than one, two and three sprays. But there was no significant difference in yield between four sprays of chlorothalonil and five and six sprays. But when compared to control, the yield was increased in almost all sprays except in one spray where there is no significant difference with the control plot.

EFFECT OF SOWING DATE ON THE INCIDENCE OF LATE LEAF SPOT ON DIFFERENT GROUNDNUT VARIETIES

Adopting safe period of sowing may also help in preventing the loss due to groundnut late leaf spot. The reaction of three promising groundnut varieties was studied with four dates of sowing at an interval of one week during kharif, 1991 under field conditions. The disease score was recorded at 50, 57, 65, 72, 80 and 87 days after sowing and presented in table 3 to 9. (Plate VII to XII).

The results indicated that, 50 DAS the early sown crop showed very less infection of late leaf spot (3.4%) compared to late sown viz., 13th July and 29th July sown crop (19.01%

and 28.40%) but 13th June and 28th June sown crops have no significant difference with respect to infection. There was no significant difference between varieties with regard to infection (Fig.3).

At 57 DAS, the early sown crop viz., 13th June and 28th June had significantly lesser infection (5.40% and 10.62%) over other two dates of sowing (29.38% and 33.33%). Similarly, 28th June sown crop had significantly higher infection (10.62%) over 13th June (5.40%) and there was no significant difference between varieties in infection. So early sown crop showed lesser infection than the late sown crop (Fig.4).

At 65 DAS, the early sown crop viz., 13th June (12.10%) and 28th June (15.08%) had no significant difference in infection, whereas there was more infection on 13th July (46.68%) and 28th July (37.28%) sown crop. There was no significant difference between the varieties with regard to infection (Fig.5).

At 72 DAS, the infection was more on 13th July (62.47%) and 28th July (56.94%) sown crop, whereas early sown crop had less infection (12.59% and 40.74%). There was no significant difference in infection between late sown crop viz., 13th July and 28th July. But 28th June sown crop had significantly higher infection (40.74%) than 13th June sown crop (12.59%). There was no significant difference in infection between varieties grown under different dates (Fig.6).

At 80 DAS, both 13th June and 28th June sown crops had less infection (33.33% and 60.00%) over late sown, (71.36% and 62.96%) and 28th June sown crop had significantly higher infection (60.00%) over 13th June sown crop (33.33%). There was more infection at both 13th July and 28th July sown crops. However there was no significant difference in infection between the varieties (Fig.7).

At 87 DAS, there was no significant difference in infection between 28th June 13th July and 28th July compared to 13th June sown crop. So only 13th June sown crop had significantly lesser infection (54.57%) than other dates of sowing. But there was no significant difference in infection between the varieties of groundnut (Fig.8).

In the light of non-significance in the yield of varieties, regression model was developed for predicting groundnut yield in terms of the date of sowing and the Per cent Disease Index (PDI). The regression model was found to be in the form

$$Y = 5.42 - 0.59 (d_1) - 0.03 (PDI)$$

where, $d_1 = 1$ for 13th June

2 for 28th June

3 for 13th July

and 4 for 28th July respectively.

The PDI in the equation was of 87 days after sowing. Both the regression co-efficients i.e. -0.59 of date of sowing and

Table: 3. Effect of date of sowing on the incidence of late leaf spot of groundnut caused by Phaeoglyphus personata at 50 DAS in promising varieties of groundnut.

Date of sowing	Varieties with percent disease incidence			
	h_1 (DH-330)	h_2 (JL-24)	h_3 (TMV-2)	Mean
A_1	10.99 (3.7)	10.24 (2.8)	11.09 (3.7)	10.77 (3.4)
A_2	18.76 (10.37)	15.81 (8.15)	13.27 (5.19)	15.94 (7.90)
A_3	24.72 (18.52)	25.62 (20.0)	24.72 (18.52)	25.02 (19.01)
A_4	33.42 (30.37)	29.98 (25.93)	32.45 (28.89)	31.95 (28.40)
Mean	21.97	20.41	20.38	20.92

Figures in the parenthesis are original values.

	<u>DOS</u>	<u>Varieties</u>
S.E.m $\pm$	3.03	0.88
C.D. at 5%	10.90	NS

DAS = Days after sowing

DOS = Date of sowing viz., A_1 , A_2 , A_3 and A_4

Date of sowing	A_1 = 13th June	A_3 = 13th July
	A_2 = 28th June	A_4 = 28th July

Table: 4. Effect of date of sowing on the incidence of late leaf spot of groundnut caused by Phaeoisariopsis personata at 57 DAS in promising varieties of groundnut.

date of sowing	Varieties with percent disease incidence			
	b_1 (DH-3030)	b_2 (JI-24)	b_3 (T7V-2)	Mean
A_1	13.60 (3.70)	11.09 (3.80)	14.88 (6.69)	13.19 (5.40)
A_2	18.76 (10.37)	19.46 (11.11)	18.76 (10.37)	18.99 (10.62)
A_3	31.24 (27.41)	35.24 (33.33)	31.31 (27.41)	32.60 (29.38)
A_4	35.20 (33.33)	35.24 (33.33)	35.24 (33.33)	35.23 (33.33)
Mean	24.70	25.25	25.05	25.00

Figures in the parenthesis are original values.

	<u>DOE</u>	<u>Varieties</u>
S.E.m $\pm$	1.12	0.53
C.D. at 5%	3.88	NS

Table: 5. Effect of date of sowing on the incidence of late leaf spot of groundnut caused by Phaeoisariopsis personata at 65 DAS in promising varieties of groundnut.

Date of sowing	Varieties with percent disease incidence			
	b_1 (DH-330)	b_2 (JL-24)	b_3 (TMV-2)	Mean
A_1	21.12 (13.33)	17.97 (9.63)	21.29 (13.33)	20.13 (12.20)
A_2	23.62 (17.03)	19.46 (11.03)	24.47 (17.03)	22.51 (15.06)
A_3	40.56 (42.25)	44.48 (49.63)	43.89 (48.15)	42.98 (46.68)
A_4	40.46 (42.22)	35.24 (33.33)	36.99 (36.30)	37.56 (37.28)
Mean	31.44	29.20	31.66	30.79

Figures in the parenthesis are original values

	<u>DOS</u>	<u>Varieties</u>
S.E.m $\pm$	3.38	0.94
C.D. at 5%	11.69	NS

Table: 6. Effect of date of sowing on the incidence of late leaf spot of groundnut caused by Phaeoisariopsis personata at 72 DAS in promising varieties of groundnut.

Date of sowing	Varieties with percent disease incidence			
	b_1 (DH-330)	b_2 (JL-24)	b_3 (TMV-2)	Mean
A_1	20.02 (11.85)	19.46 (11.11)	22.55 (14.81)	20.68 (12.99)
A_2	41.32 (43.70)	38.70 (39.26)	38.70 (39.26)	39.57 (40.74)
A_3	50.91 (60.00)	52.77 (62.96)	53.64 (64.44)	52.44 (62.47)
A_4	48.22 (55.56)	47.35 (54.07)	50.78 (60.0)	48.78 (56.54)
Mean	40.12	39.57	41.41	40.37

Figures in the parenthesis are original values.

	<u>DOE</u>	<u>Varieties</u>
S.E.m $\pm$	2.63	0.51
C.D. at 5%	9.11	NS

Table 7: Effect of date of sowing on the incidence of late leaf spot of groundnut caused by phaeoglyphis peronata at 80 DAS in promising varieties of groundnut.

Date of sowing	Varieties with percent disease incidence			
	b_1 (DH-3-30)	b_2 (JL-24)	b_3 (TMV-2)	Mean
A_1	35.23 (33.33)	35.24 (33.33)	35.18 (33.33)	35.21 (33.33)
A_2	49.92 (58.52)	50.85 (60.00)	51.77 (61.48)	50.84 (60.00)
A_3	57.96 (71.85)	60.89 (76.30)	57.82 (65.93)	58.89 (71.36)
A_4	50.78 (60.00)	52.62 (62.96)	54.40 (65.93)	52.60 (62.96)
Mean	48.47	49.90	49.79	49.39

Figures in the parenthesis are original values

	<u>DOS</u>	<u>Varieties</u>
S.E.m $\pm$	2.24	0.86
C.D. at 5%	7.74	NS

Table 8 : Effect of date of sowing on the incidence of late leaf spot of groundnut caused by Phaeoisariopsis personata at 87 DAS in promising varieties^d of groundnut.

Date of sowing	Varieties with percent disease incidence			
	b_1 (DH-330)	b_2 (JL-24)	b_3 (TMV-2)	Mean
A_1	47.88 (54.81)	46.52 (52.59)	48.73 (56.3)	47.71 (54.57)
A_2	58.71 (73.33)	58.96 (73.33)	57.12 (70.37)	58.26 (72.34)
A_3	61.89 (77.78)	61.89 (77.78)	61.89 (77.78)	61.89 (77.78)
A_4	58.96 (73.33)	58.96 (73.33)	59.96 (74.81)	59.29 (73.82)
Mean	56.86	56.88	56.92	56.79

Figures in the parenthesis are original values.

	<u>DOS</u>	<u>Varieties</u>
S.E.m $\pm$	2.70	0.64
C.D. at 5%	9.34	NS

Legend

A_1 = 13 th June

A_2 = 20th June

A_3 = 13th July

A_4 = 20th July

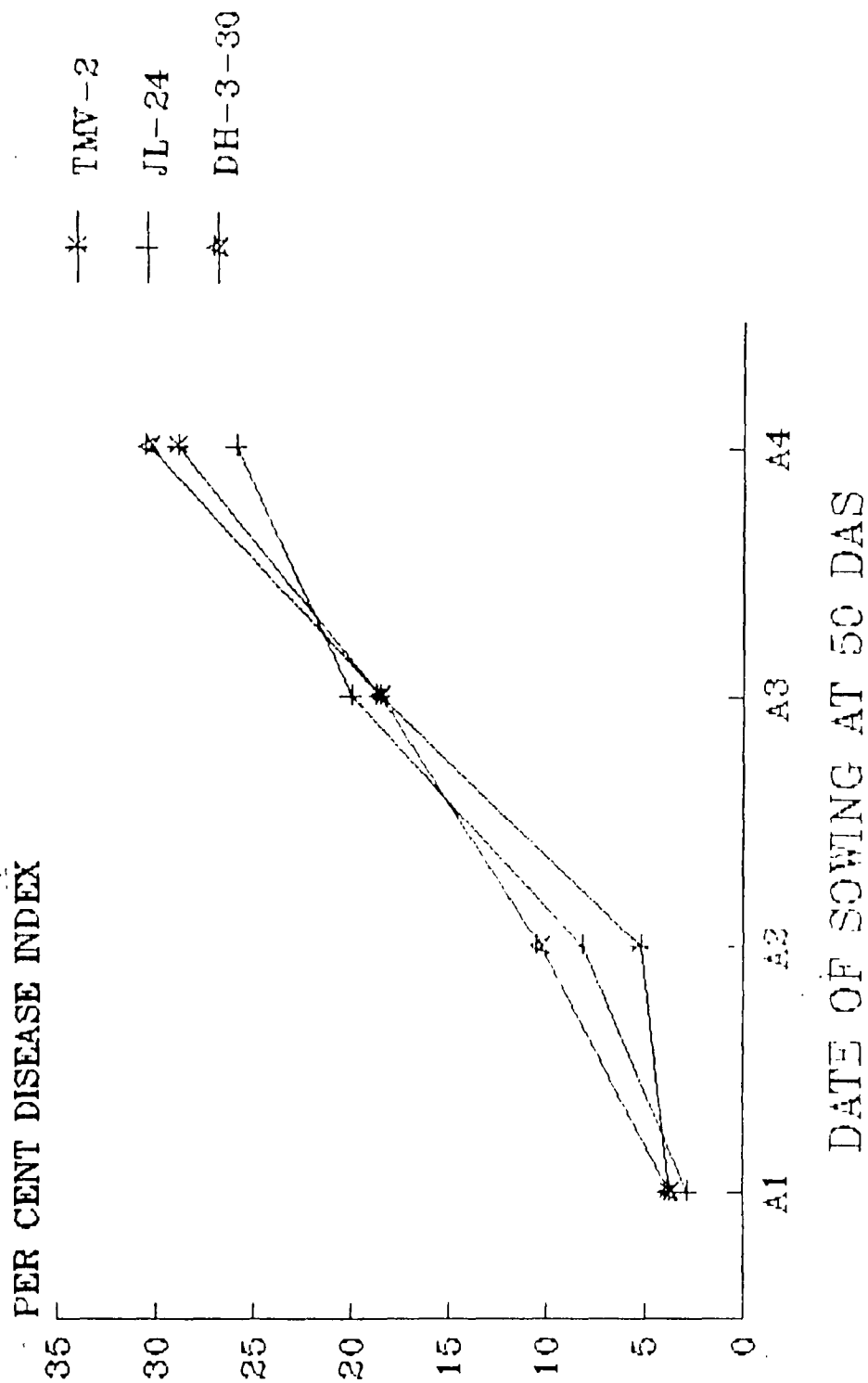


FIG. 3. SEVERITY OF LATE LEAF SPOT OF GR-
GUNDNUT (*P. personata*) AT 50 DAS ON DIF-
FERENT SOWING DATES.

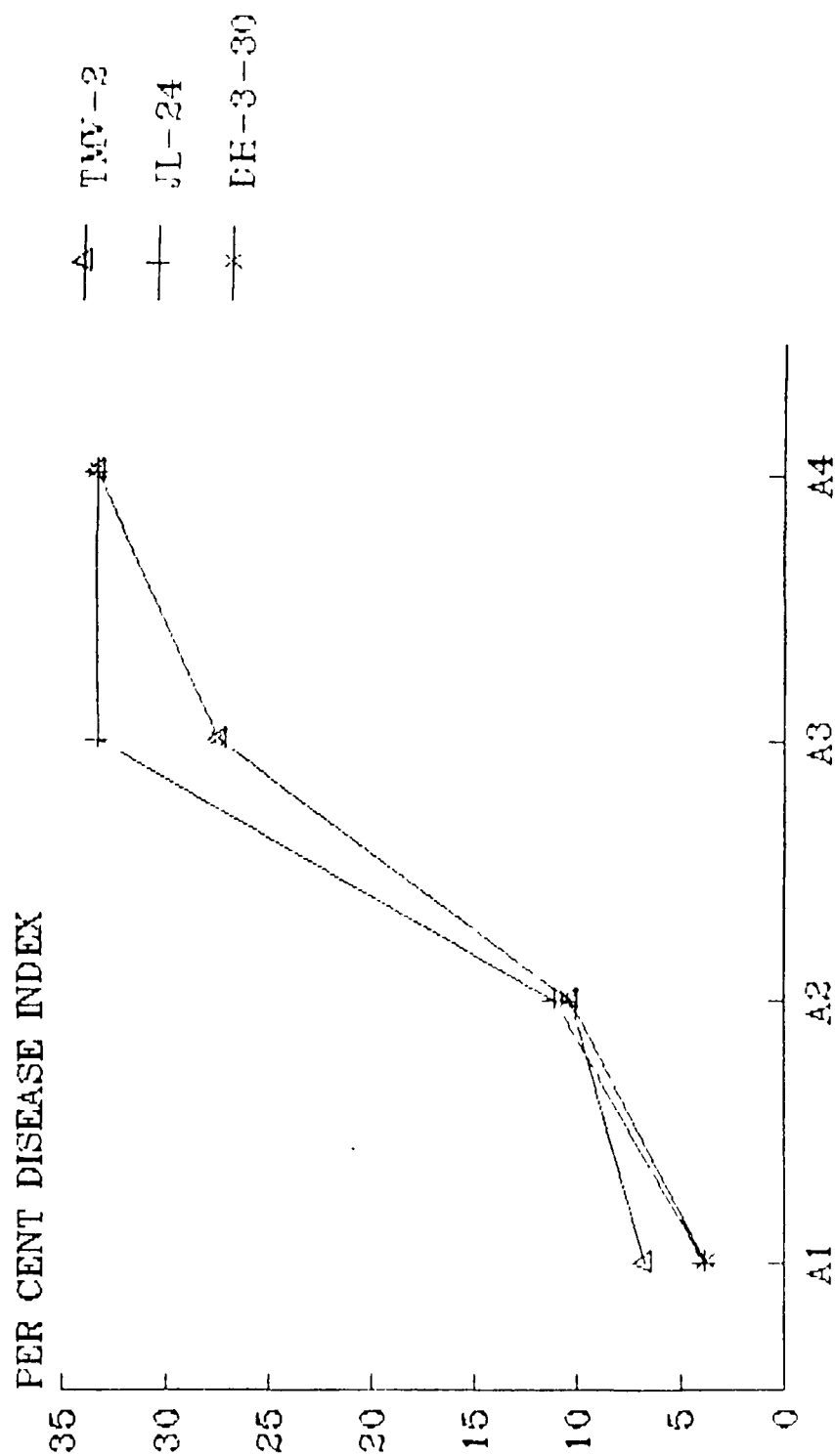


FIG.4. SEVERITY OF LATE LEAF SPOT OF GR-
OUNDNUT (*P. personata*) AT 57 DAS ON DIF-
FERENT SOWING DATES.

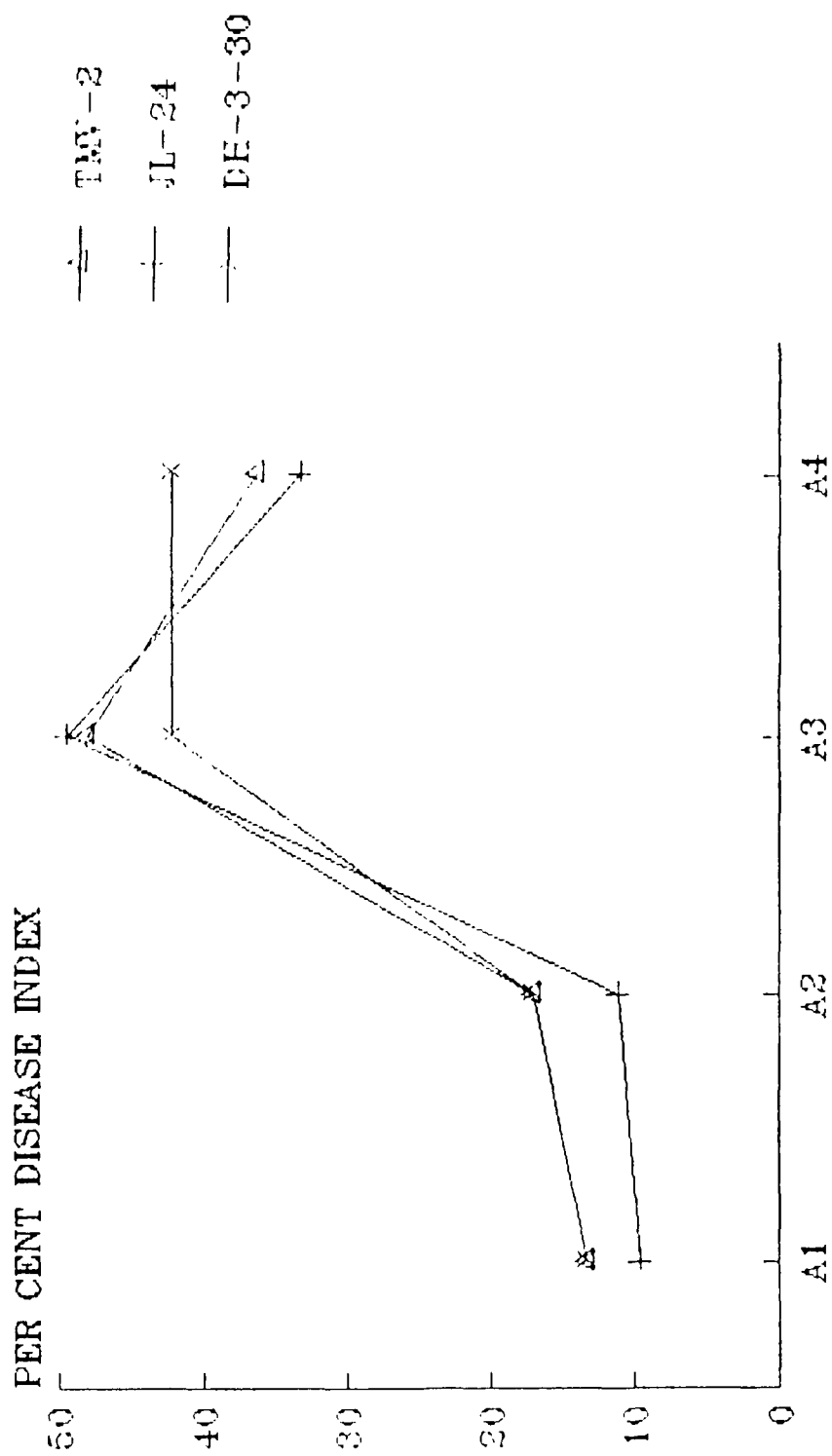
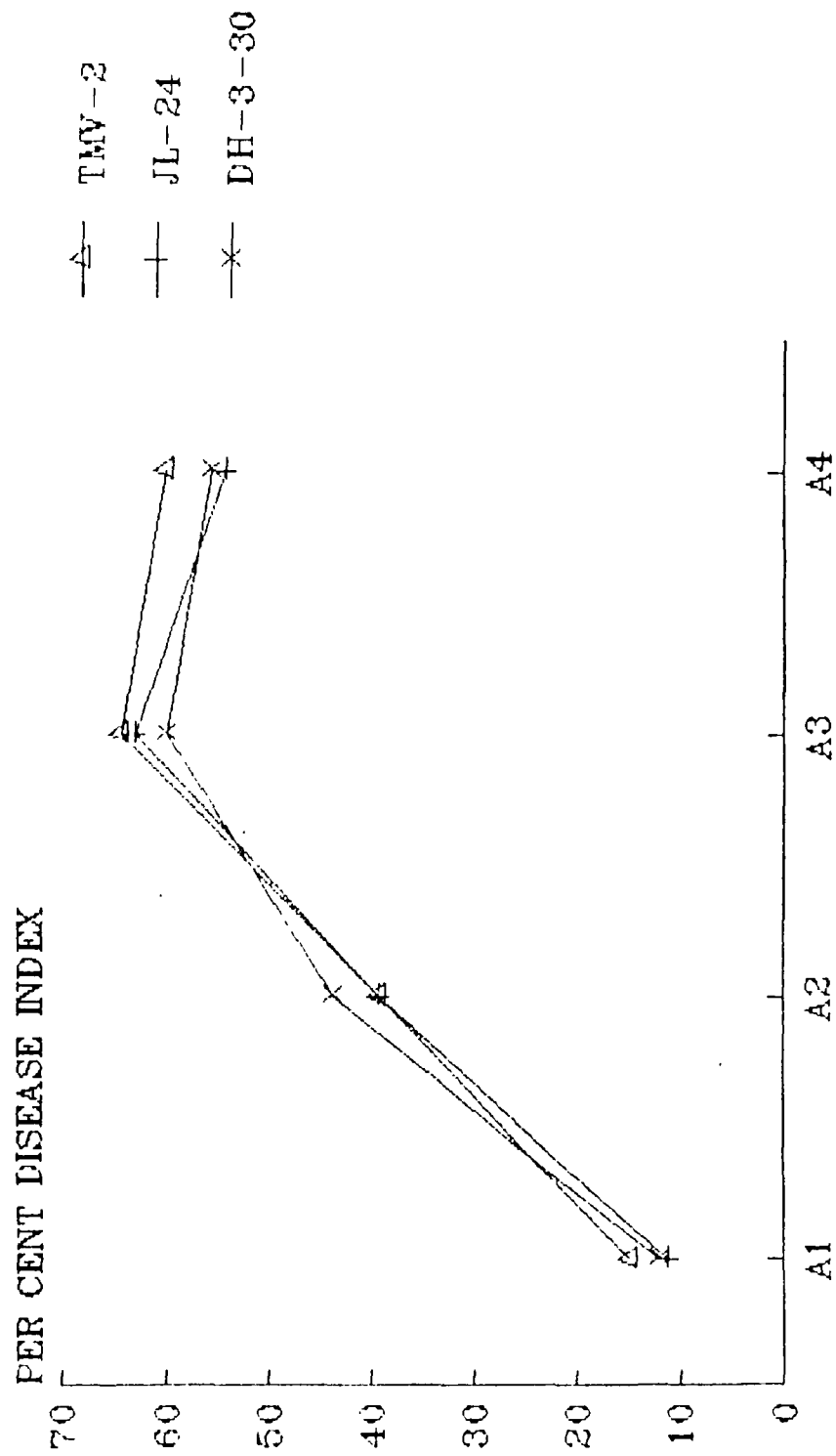


FIG. 5. SEVERITY OF LATE LEAF SPOT OF GR-
GUNDNUT (*P. personata*) AT 65 DAS ON DIF-
FERENT SOWING DATES.



DATE OF SOWING AT 72 DAS

FIG.6. SEVERITY OF LATE LEAF SPOT OF GR-
CUNDNUT (P. personata) AT 72 DAS ON DIF-
FERENT SOWING DATES.

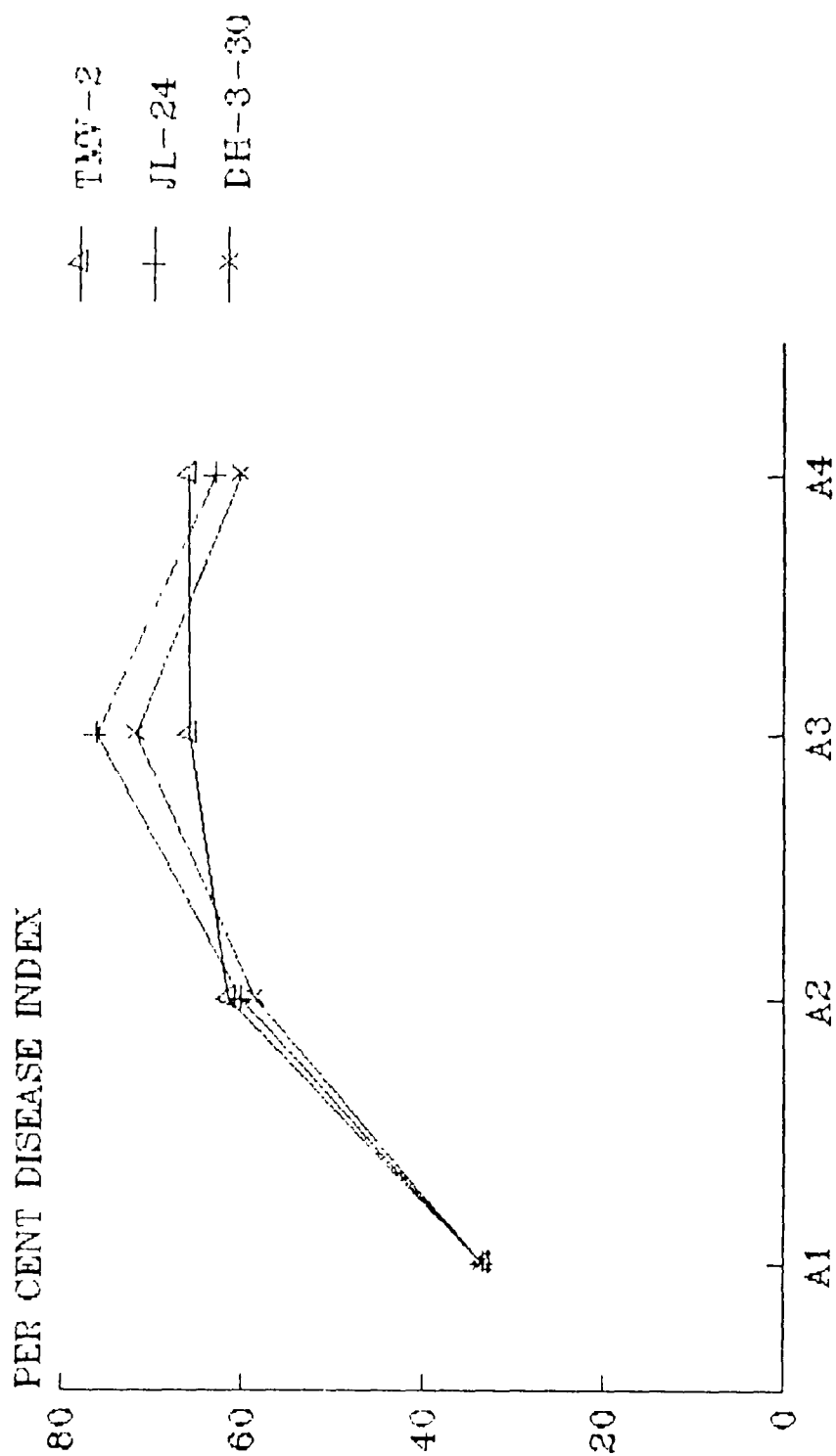


FIG.7. SEVERITY OF LATE LEAF SPOT OF GR-
 OUNDNUT (*P. personata*) AT 80 DAS ON DIF-
 FERENT SOWING DATES.

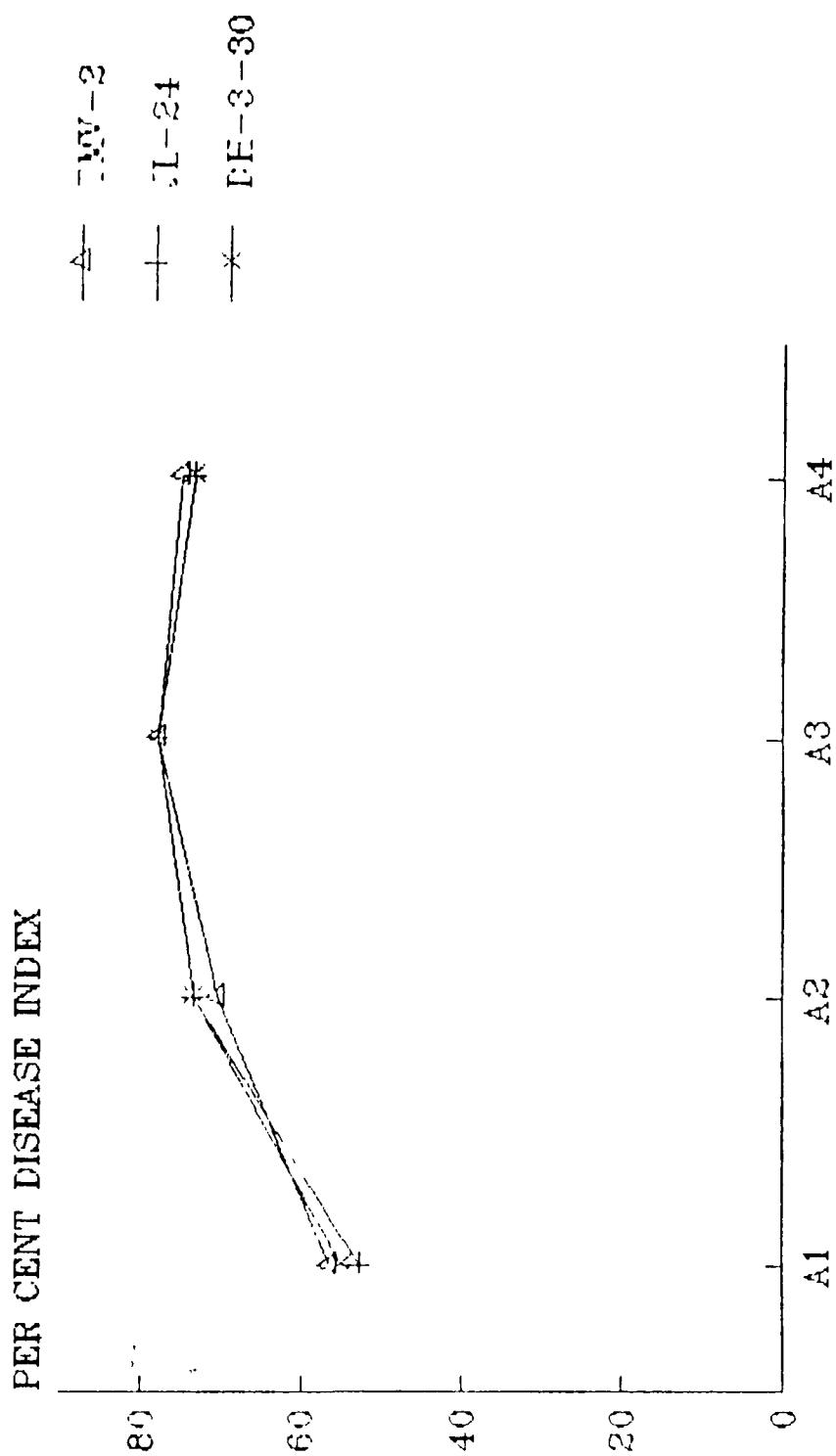


FIG.8. SEVERITY OF LATE LEAF SPOT OF GR-
 OUNDNUT (*P. personata*) AT 87 DAS ON DIF-
 FERENT SOWING DATES.

Plate No. VII. Photograph showing severe attack of
late leaf spot of groundnut at 85 DAS.

Plate No. VIII. Photograph showing severe attack of
late leaf spot of groundnut at 85 DAS.



Plate No. VII



Plate No. VIII

Plate No. IX. Photograph showing effect of sowing
date on late leaf spot of groundnut
(A₂-28th June).

Plate No. X. Photograph showing effect of sowing
date on late leaf spot of groundnut
(A₃-13th July).



Plate No. IX



Plate No. X

Plate No. XI. Photograph showing effect of sowing date on late leaf spot of groundnut (A₄-28th July).

Plate No. XII. Photograph showing comparison of effect of different sowing dates on the incidence of late leaf spot of groundnut.



plate No. XI



plate No. XII

LEGEND

1. Glucose 1%
2. Glucose 2%
3. Lactose 1%
4. Lactose 2%
5. Maltose 1%
6. Maltose 2%
7. Sucrose 1%
8. Sucrose 2%
9. Tap water.

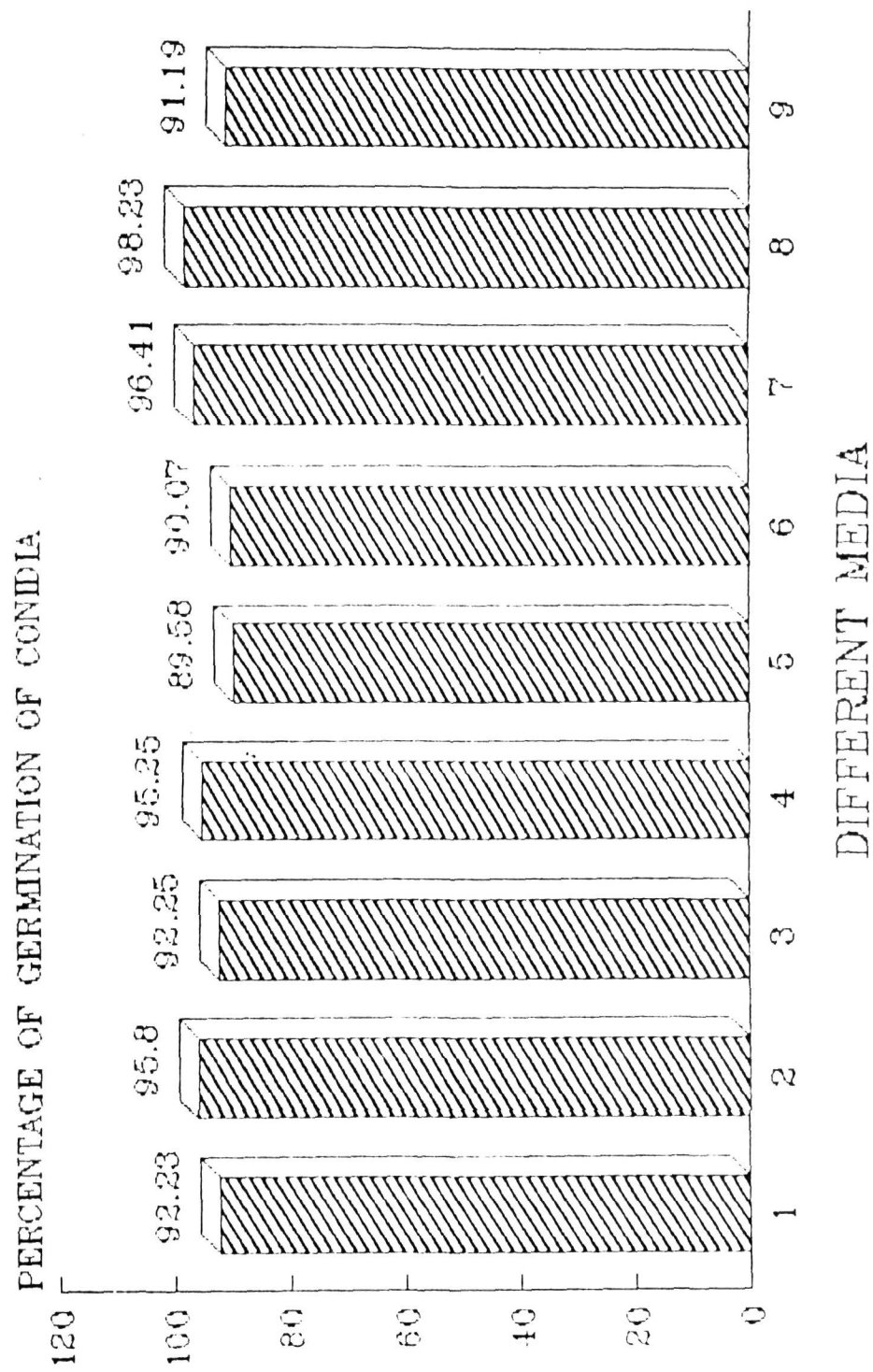


FIG. 9. PER CENT GERMINATION OF CONIDIA
OF *P. personata* IN DIFFERENT MEDIA AFTER
24 HOURS OF INCUBATION.

-0.03 of PDI at 87 days after sowing, were found to be significant at 5% level of significance. The co-efficient of determination was found to be 0.77, indicating that the groundnut yield with the help of above regression model, can be predicted with 77% confidence in terms of date of sowing and PDI at 87 days after sowing.

Effect of date of sowing on pod yield in different promising varieties of groundnut

The pod yield data (table 9) indicated that, 13th June and 28th June differed significantly with other dates of sowing. The 13th June sown crop differed significantly from 28th June sown crop and had significantly higher yield (3.37 kg/plot) than 28th June (1.58 kg/plot) and other two dates of sowings. The maximum yield was obtained on 13th June sown crop and the minimum on 28th July sown crop (0.96 kg/plot). Among the varieties, JL-24 recorded (1.95 kg/plot) significantly higher yield over TMV-2 (1.43 kg/plot) and did not differ significantly with Dh-3-30 (1.82 kg/plot).

GERMINATION OF CONIDIA IN DIFFERENT MEDIA

Germination of conidia requires several factors, some of which are substrate, suitable temperature and humidity etc. In this experiment, the germination of conidia in different media was studied and the results are presented in Table 10.

Table 9: Effect of date of sowing on the incidence of late leaf spot of groundnut caused by Phaeoisariopsis personata and yield.

Date of sowing	Mean yield - kg per plot			
	Varieties			Mean
	b_1 (DH-330)	b_2 (JL-24)	b_3 (TNV-2)	
A_1	3.38	3.91	2.81	3.37
A_2	1.78	1.53	1.45	1.58
A_3	1.15	1.20	0.73	1.03
A_4	0.98	1.16	0.73	0.96
Mean	1.82	1.95	1.43	1.73

	<u>D.F.</u>	<u>Variation</u>
S.E.m $\pm$	0.09	0.12
C.D. at 5%	0.33	0.36

**Table: 10. Percent germination of conidia of Phaeoisariopsis
persoonii in different media at different incubation
periods.**

Media	Incubation period (hours)						
	6	9	12	15	18	21	24
Glucose 1%	6.76	10.91	49.92	61.73	83.12	91.93	92.23
Glucose 2%	7.31	12.01	51.63	63.41	80.03	95.80	95.80
Lactose 1%	0.00	10.01	38.05	49.52	71.64	89.98	92.25
Lactose 2%	0.00	10.23	43.24	52.63	79.46	95.24	95.25
Maltose 1%	0.00	7.29	33.42	46.69	71.52	89.21	89.58
Maltose 2%	0.00	9.22	35.84	49.19	72.88	89.81	90.07
Sucrose 1%	8.58	14.36	59.94	69.81	81.91	95.59	96.41
Sucrose 2%	10.26	16.61	62.01	71.92	83.24	96.83	98.23
Tap water	0.00	6.09	34.03	51.84	70.49	91.09	91.19

The germination percentage was recorded after 6, 9, 12, 15, 18, 21 and 24 hours of incubation. The maximum per cent of conidial germination (98.23 per cent) was recorded in two per cent sucrose solution followed by one per cent sucrose solution (96.41 per cent), two per cent glucose solution (95.80 per cent) and two per cent lactose solution (95.25 per cent). Comparatively less germination of conidia was observed in tap water (91.19 per cent) and two per cent maltose solution (89.58 per cent) (table 10).

In this study, the influence of incubation period on spore germination was also evident. In the beginning, upto 6 hours, the germination rate was not quite high, but considerable increase in germination percentage was noticed after 9 hours of incubation. Further increase in germination percentage was not evident at 21 and 24 hours of incubation (Fig.9).

PERPETUATION OF THE PATHOGEN IN THE HOST DEBRIS

As a part of the epidemiological studies the viability and survival of conidia were studied during kharif, 1991. Hence, an attempt was made ^{to} study the survival ability of the conidia, and results are presented in table 11.

The studies revealed that the conidia remained viable for 105 days under natural conditions, whereas they remained viable for 151 days in the laboratory and 151 days in the glass

**Table 11: Survival of conidia of Phaeoisariopsis griseoviridis
in plant debris under different storage conditions**

Storage conditions	Survival of conidia (in days)
1. Glass house	151
2. Laboratory	151
3. Natural condition	105
4. Refrigerator	161

house conditions. But at low temperature of 6°C the conidia of the pathogen remained viable till 181 days.

BIOCHEMICAL ANALYSIS

Biochemical analysis was carried out to know the effect of late leaf spot infection on chemical constituents of groundnut viz., sugar and phenol contents in leaf. Variety JL-24 of groundnut was used for analysis of sugars and phenols.

The late leaf spot infection increased total sugar content, whereas, total phenol content was decreased due to infection. The total sugar content of healthy leaf sample was 0.76 mg per g and 1.45 mg per g in diseased leaf. But the total phenol content of healthy leaf sample was 0.97 mg per g and 0.37 mg per g in diseased leaf (table 12).

REACTION OF PROMISING VARIETIES OF GROUNDNUT AGAINST LATE LEAF SPOT

Growing resistant varieties is the most economical and safe method of controlling the late leaf spot of groundnut. In order to, identify the resistant cultivars, 12 promising groundnut varieties were screened against late leaf spot during kharrif, 1991 under natural conditions at Dharwad. The late leaf spot incidence was recorded at maturity stage of the crop and results are presented in table 13 (Plate XIII to XV).

Table 12: Effect of late leaf spot of groundnut caused by Phaeoisariopsis personata on chemical constituents of groundnut leaves (Cv. JL-24).

Sl.No.	Chemical constituents (mg/gm)		
1.	<u>Total phenols in leaves</u>		
a)	Healthy	...	0.97
b)	Diseased	...	0.37
2.	<u>Total sugars in leaves</u>		
a)	Healthy	...	0.76
b)	Diseased	...	1.45

Table 13: Reaction of groundnut genotypes to late leaf spot caused by Phaeoisariopsis personata.

Sl.No.	Genotype	Reaction (Score)
1	Dh-8	6.1
2	Dh-39	7.0
3	Dh-40	6.6
4	Dh-330	6.6
5	ICGV-67264	5.2
6	JL-24	6.8
7	KRO-1	7.0
8	PI-393316	2.6
9	R-8972	6.6
10	S-206	6.8
11	Spanish Improved	6.3
12	TRV-2	7.0

**Plate No. XIII. Photograph showing highly susceptible
groundnut genotype (KRG-1)-Unprotected.**

**Plate No. XIV. Photograph showing protected plot of
groundnut genotype (KRG-1).**



Plate No. XIII



Plate No. XIV

Plate No. XV. Photograph showing moderately
resistant groundnut genotype
(PI-393516).



Plate No. XV

LEGEND

- C₁ = Mancozeb (Dithane M-45)**
- C₂ = Carbendazim (Revistin)**
- C₃ = Bitertanol (Baycor)**
- C₄ = Chlorothalonil (Kavach)**
- E₁ = Coconut leaf extract**
- P₁ = Sorghum leaf extract**
- P₂ = Neem leaf extract**
- P₄ = Parthenium leaf extract**
- Control**



FIG.10.EFFECT OF PLANT EXTRACTS AND FUNGICIDES ON

LATE LEAF SPOT OF GROUNDNUT CAUSED BY

Phaeoisariopsis personata

Plate No. XVI. Photograph showing effect of carbendazim (Bavistin) and bitertanol (Baycor) in control of late leaf spot of groundnut.

Plate No. XVII. Photograph showing effect of parthenium leaf extract and chlorothalonil (Kavach) on late leaf spot of groundnut.



Plate No. XVI



Plate No. XVII

Plate No. XVII. Photograph showing protected
(chlorothalonil) and unprotected/
control plots of groundnut.

Plate No. XIX. Photograph showing effect of
carbendazim (Bavistin) in control
of late leaf spot of groundnut.

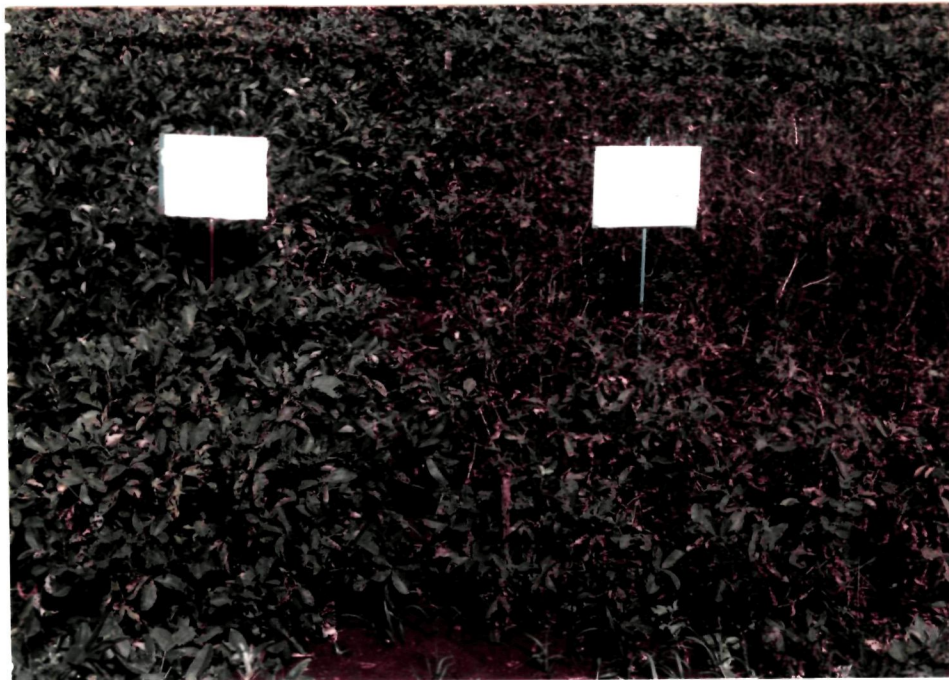


Plate No. XVIII



plate No. XIX

The results from the table 13 revealed that, the disease was noticed on almost all the varieties of groundnut. None of the variety was found to be immune to the disease. But the disease incidence was less in PI 393516 (2.6 score) compared to rest of the varieties under study. Where as, KRG-1, TMV-2 DH-39 showed maximum infection of 7.0 score. While, remaining varieties showed infection above 6.0 score and below 7.0 except ICGV-67264 (5.2 score) which showed little less than 6.0 score.

EFFECT OF PLANT EXTRACTS AND FUNGICIDES ON LATE LEAF SPOT OF GROUNDNUT

The field trial was conducted at Main Research Station, University of Agricultural Sciences, Dharwad by using JL-24 with four plant extracts viz., coconut leaf extract, neem leaf extract, parthenium leaf extract and sorghum leaf extract, and four fungicides viz., mancozeb (Dithane M-45), carbendazim (Bavistin), chlorothalonil (Kavach) and bitertanol (Baycor). The data pertaining to this study are presented in table 14 (Plate XVI to XIX, Fig.9).

The results indicated that, there was not much control of the disease noticed by using plant extracts compared to chemicals. But neem leaf extract spraying increased the yield than the rest of the plant extracts used. Carbendazim gave good results over the other fungicides and plant extracts, where

Table 14: Effect of plant extracts and fungicides on late leaf spot of groundnut caused by Phaeoisariopsis personata and yield.

Sl.No.	Treatments	PDI at 75 DAS	Yield (gm/plot)
1.	C ₁ Mancozeb (Dithane M-45)	39.57	463.33
2.	C ₂ Carbendazim (Revistin)	29.98	780.00
3.	C ₃ Bitertanol (Baycor)	35.24	760.00
4.	C ₄ Chlorothalonil (Kavach)	35.24	751.67
5.	P ₁ (Coconut leaf extract)	32.77	551.67
6.	P ₂ (Sorghum leaf extract)	48.22	561.67
7.	P ₃ (Neem leaf extract)	48.22	710.00
8.	P ₄ (Portulacium leaf extract)	48.22	541.67
9.	Control	71.26	411.67

	<u>PDI</u>	<u>Yield</u>
S.E.m $\pm$	3.94	4.53
C.D. at 5%	11.81	11.17

the disease incidence was less and yield was also increased. This was followed by bitertanol and chlorothalonil.

It is evident from the table that, effect of plant leaf extracts in controlling the disease completely is not significant i.e., there was no significant difference with respect to infection between all plant leaf extract, sprays but significantly reduced the disease by these sprays compared to control plots. Similarly, among the fungicides there was no significant difference in infection but disease incidence was lesser compared to plant leaf extract sprays and control.

Increased pod yield by spray of fungicides and plant leaf extracts was observed compared to control. But there was no significant difference in yield between bitertanol (760 g/plot) and chlorothalonil (751.67 g/plot) and similarly between plant leaf extracts except neem leaf extracts (710.00 g/plot) where yield was increased significantly.

But carbendazim (Bavistin) application showed higher yield (780 g/plot) than other chemicals and plant leaf extract sprays. The results indicated that, by application of fungicides, pod yields can be increased considerably.

CHAPTER - V

DISCUSSION

V DISCUSSION

The late leaf spot of groundnut caused by Phaeoisariopsis peronata (Berk. and Curt.) V. Arx. is one of the major diseases throughout the world. In India, this disease is taking heavy toll of the crop every year. Though the disease has been studied extensively, but still, there are many obscure points with regard to the disease and pathogen which need thorough elucidation. Therefore, in the present study, the different aspects of investigations on late leaf spot of groundnut that are being carried out which include survey and surveillance for the disease to identify endemic areas, estimation of yield loss due to disease, effect of late leaf spot incidence in relation to variety and time of sowing, influence of substrates on the germination of conidia, locating the probable source or sources of inoculum, effect of the disease on the chemical constituents of leaf viz., total sugars and phenol contents, identification of resistant varieties and effect of plant extracts and chemicals in controlling the disease.

An intensive survey was carried out during kharif, 1991, in Northern Karnataka to get the precise information on intensity of the disease, distribution and spread in different localities. This information is useful to identify the 'hot spots' in Dharwad and Belgaum districts. The data on

survey revealed that, the incidence of disease varied from locality to locality because of type of variety, inoculum load and environmental conditions. The disease was severe in Ramdurg and Dharwad talukas. The reduction in yield is largely due to damage caused to the leaves as a result of intense spotting and consequent loss in photosynthetic tissue. This aspect has been reported by Gerlagh and Bohdan, (1974). The pathogen survived best when rainfall, relative humidity and minimum and maximum temperatures were low. The seed borne inoculum is of minor importance. Similar type of studies have been reported in tikka disease of groundnut by Sulaiman and Agashe (1965). Rains are probably, useful in spore dispersal and in inducing leaf wetness, but relative humidity appears to be the best measure of all factors which affect duration of leaf wetness within the entire crop canopy, influencing favourable periods. This aspect was earlier reported by Jensen and Boyle (1965).

Survey was conducted at different groundnut growing areas of Dharwad and Belgaum districts. The studies revealed that, the temperature and humidity are considered as important factors for the establishment, multiplication and spread of the disease. The temperature in the range of 25 to 30°C and high relative humidity favoured the infection and disease development (Mc Donald et al., 1965). A period of three days of high humidity is essential for maximum infection by the

pathogen (Renukrishna and Apparao, 1966). Late leaf spot was particularly severe in Remdurg and Dharwad talukas probably, because of extensive and continuous (50 to more than 50 per cent disease) cultivation of groundnut crop. These results are in agreement with the survey conducted by Subrahmanyam and Mc Donald, (1966) and Mc Donald et al., (1968) in case of leaf spots of groundnut.

The late leaf spot of groundnut is the destructive disease causing heavy loss in yield every year. So by minimizing the disease incidence, the yield loss could be reduced. It was observed that, the reduction in the yield was due to late leaf spot disease. The data revealed that, yield was reduced in control treatment compared to fungicide (Chlorothalonil) treated plots and also the disease incidence was high in control plots than fungicide treated plots, thus indicating relationship between the disease and also yield. Chlorothalonil, an effective fungicide for late leaf spot disease, was used to control the disease with different number of sprays and yield also increased due to reduction^{of} disease by using chlorothalonil. The disease incidence was reduced in all the sprays of chlorothalonil when compared to control. It could be revealed from the data that the yield was increased by using chlorothalonil which reduced the disease significantly. The yield was significantly higher in four sprays of chlorothalonil (6.30 kg/plot) than one, two and three sprays of

chlorothalonil and so also disease was low in four sprays of fungicide (35.24 per cent) application.

To find out optimum number of sprays of chlorothalonil required to control late leaf spot, it was found that four sprays of fungicide reduced the disease intensity (35.24 per cent) and yield also increased (6.30 kg/plot). In absence of effective fungicides, leaf spots frequently reduced pod yield as much as 50 per cent. These findings are in agreement with Subrahmanyam et al. (1982) in case of leaf spots of groundnut.

The weather conditions play an important role on the incidence of late leaf spot in the field and by adjusting the date of sowing of the crop, the disease could be checked effectively. Hence, it is essential to findout the safer period of sowing of the crop. The disease escape mechanism is one of the practices followed to minimise the losses due to various diseases in different crops. In the present investigation, groundnut varieties viz., Dh-3-30, JL-34 and TNV-2 were sown at an interval of fifteen days with four dates of sowing. It was found that, the appearance of the disease and weather factors decide the development of late leaf spot in a particular situation. The results of the experiment revealed that, June 13th and June 28th sown crops showed less incidence of the disease (3.40% and 7.90%) than July 13th and July 28th sown crops (19.01% and 28.40%) in the

field at 50 days after sowing. At 57 days after sowing also, early sown crop was less infected compared to July sown crop. Even the infection was significantly lesser in 13th June sown crop (5.40%) than 28th June sown crop (10.62%). Similar observations were made after 65, 72, 80 and 87 days after sowing. This indicates that the early sown crop viz., June 13th and June 28th suffered less compared to July sown crop. It may be because of coincidence of favourable conditions like temperature, cooler temperature (25 to 28°C), high relative humidity ($>95\%$) and abundant spore load in the atmosphere coupled with intermittent rainfall. In June sown crop, because of unfavourable climatic conditions in the atmosphere, the disease development was less, where as, late sown crop suffered from maximum infection because of the high inoculum load in the atmosphere. These observations are in accordance with the findings of Gupta (1985); Lewin *et al.* (1973) in case of leaf spots of groundnut. However, there was no significant difference in infection between varieties at all the stages of observation.

Late sowing ('July' sowing) of the crop is most vulnerable, since the late leaf spot may appear in epiphytotic and thereby affecting the yield drastically. The reduction in yield is not only due to late leaf spot infection, but also due to other biotic and abiotic causes. So, it could be concluded that the early sown (June month) crop suffers less

due to infection from late leaf spot as compared to the crop sown late (July month) in the season. Hence, both the, time of sowing and late leaf spot incidence were found to be negatively correlated with yield. This is also revealed by the regression model of yield on date of sowing and per cent disease index at 87 days after sowing. With the multiple correlation co-efficient as high as 0.83 i.e. with the co-efficient of determination as 0.77, it was inferred that the groundnut yield can be predicted in terms of date of sowing and per cent disease index at 87 days after sowing with 77 per cent confidence. This showed that, the remaining 23 per cent of variation might have been due to extraneous factors like insects attack, weeds etc. This also indicated that there is scope for improvement of the prediction model incorporating other factors namely loss due to insect attack, weeds, population etc. Similar type of observations were obtained by Gupta (1985), Lawin et al. (1973) and Ravindranath and Kulkarni (1967). Hence, it is advantageous to take up sowing early to prevent the outbreak of late leaf spot, especially in endemic areas of Northern Karnataka.

Certain substances are essential for conidia to germinate and to support the further activities. Studies on conidial germination have revealed that, the maximum germination was recorded in two per cent sucrose solution after 24 hours, while, it comparatively less in maltose 1% and 2% and tap water.

Glucose 2% and Sucrose 1% and Sucrose 2% were found to be suitable media for maximum germination of conidia. These findings are in agreement with Somnartya and Beute (1986) in Cercosporidium personatum. Hence, comparatively less germination of conidia in maltose 1% and 2% and tap water may be due to lack of essential nutrients required by the pathogen for germination.

As a part of epidemiological studies, the perpetuation of the pathogen in host debris was also studied. The late leaf spot affected leaves were collected and preserved under refrigerated conditions, laboratory, glass house and open field conditions. Such samples were taken out periodically and tested for viability by observing the germination of conidia. Investigations on viability and survival of conidia of Phaeoisariopsis personata revealed that, the conidia remained viable for 105 days under natural conditions, 151 days in both house and laboratory conditions and 181 days under refrigerated conditions. The incidence of late leaf spot in continuously cropped area assumes importance in the present investigation. Here, the survival of pathogen was studied based on the germination of conidia. But Ramapanda and Rao (1982) reported that, 75 days of survival of pathogen in infected debris but the study was done based on the expression of symptoms on host by inoculation with viable conidia.

Biochemical studies were carried out to compare and find out the role of chemical constituents of diseased and healthy plants. The late leaf spot infection definitely altered the physiology of the host. In the present study, it can be observed that, the late leaf spot infection increased the total sugar, reducing sugar and decreased the phenol contents of leaf as compared to healthy plant. Similar observations were made by Gupta et al. (1985), Brahmachari and Kolte (1983), in case of leaf spot diseases of groundnut.

The increase in total sugar and decrease in total phenols closely related to severity of the late leaf spot infection in a given situation. Increase in total sugar may be due to their accumulation, as a result of disruption of normal phloem transport. Total phenol content was more in healthy leaves and less in diseased leaves. This indicates, total phenol content in the leaf imparts resistance against late leaf spot pathogen. However, the studies indicated that, the chemical constituents are definitely playing a role in the susceptibility or resistance mechanism in the host-pathogen system under study.

The effective, economical and less risky method of keeping the activity of late leaf spot pathogen under control is by cultivation of resistant varieties. Hence, with this objective in mind, the promising groundnut genotypes were

evaluated for their field resistance to late leaf spot. The studies revealed that the genotype PI-393516 showed slight resistance to the disease compared to other genotypes but remaining genotypes under study showed higher disease incidence. Actually none of the genotypes was found to be completely resistant to the late leaf spot, under study. The groundnut cultivars viz., KRG-1, TMV-2, Dh-39 were found to be highly susceptible to the disease. Hence, none of the genotype was suitable to recommend as fully resistant cultivars to the disease but PI-393516 and ICGV-57264 had shown moderate resistance to the disease. Whereas, remaining genotypes were found to be highly susceptible to the late leaf spot disease of groundnut. These may be used in the resistance breeding programme.

Experimental results suggested that, even with plant leaf extracts and fungicides, the incidence of late leaf spot could be minimised. The experimental evidence obtained from study suggests the superiority of carbendazim, bitertanol, chlorothalonil and neem leaf extracts compared to rest of the treatment under report. Among leaf extracts, neem leaf extract spray showed higher yield than other leaf extracts under study. But overall, carbendazim showed little disease incidence and also increase in yield than all the treatments. But no such significant reduction in the incidence of disease compared to other leaf extract sprays was noticed in the study but only neem

leaf extract increased the yield in comparison to other leaf extracts and control. Antimicrobial properties of many plant extracts have also been reported by several other workers in the past (Sahgal 1961, Kalaichelvan and Mahadevan 1988).

This study is also in accordance with the findings of Ghewande 1989. Hence, chemical sprays i.e., carbendazim controlled disease effectively and also increased yield significantly than rest of the treatments. Among leaf extracts, neem leaf extract spray was found to be effective in reducing the disease and to increase the yield.

*Future Line of Work

The following future lines of work are suggested to understand the different aspects of the late leaf spot of groundnut.

1. The survey and surveillance systems for late leaf spot of groundnut have not been established systematically in the country. It would provide reliable information on the changes of disease complex in dynamic agricultural system thus in turn helping to prevent epiphytotic through such measures as replacement or readjustment of crop varieties and agricultural practices.
2. Biochemical parameters may be studied in relation to resistance especially with regard to components of

phenols may be identified for resistance in the genotypes. Individual biochemical parameters may be studied at different stages of crop growth in different varieties.

3. Effect of levels of fertilizer application and irrigation may be studied in management of the disease. There was some evidence in Nigeria that heavy weed growth in groundnut fields led to increased severity of leaf spot diseases. Similar studies need to be carried out by research workers on late leaf spot in future.
4. There is a need to identify and detect the virulence of P. personata in order to reorient the breeding programme for disease resistance.
5. There are interesting hyperparasites existing to reduce late leaf spot severity, and research should be encouraged, particularly in those areas where the hyperparasites commonly occur or isolation of antagonistic organisms, and testing them on a large scale to manage the disease.
6. Botanical pesticides may be evaluated in control of groundnut late leaf spot. Such pesticides will be of great help not only in combating the disease but also to overcome the pollution and health hazards.

7. Efforts are required to be made in utilizing all available control measures in an integrated way wherever possible in order to enhance groundnut production.
8. Additional information on cultural and biological management of late leaf spot of groundnut may be generated for designing integrated management of the disease.

CHAPTER - VI

SUMMARY

VI SUMMARY

Late leaf spot of groundnut (Arachis hypogaea L.) caused by Phaeoearharia peronata (Berk. and Curt.) V. Arx., has long been recognised as the most destructive disease of groundnut. The importance of the late leaf spot disease on groundnut is very well known and it is endemic throughout groundnut growing areas of the world.

The present investigations on late leaf spot of groundnut caused by Phaeoearharia peronata (Berk. and Curt.) V. Arx., were made with respect to the following objectives viz., survey and surveillance for the incidence of late leaf spot in major groundnut growing areas of northern Karnataka, estimation of loss in yield due to late leaf spot, effect of date of sowing on the incidence, study of germination of conidia in different media, perpetuation of the pathogen in the host debris, effect of disease on the biochemical constituents in groundnut cultivars and management of the disease through plant extracts, fungicides and host plant resistance. The experiments were carried out during kharif, 1991 at the Main Research Station, University of Agricultural Sciences, Dharwad. The results of the investigation are summarised here under.

Survey carried out during kharif, 1991 revealed that,

the severity of late leaf spot of groundnut was recorded more at Ramdurg and Dharwad talukas. Hence, these areas may be considered as "hot spots" for late leaf spot infection. But the incidence of the disease was recorded as moderate at Bailhongal, Saundatti and Hubli talukas.

It was observed that, the yield loss was high in disease affected plots compared to chlorothalonil sprayed plots. Chlorothalonil reduced the disease significantly and increased the yield considerably. It was found that, four sprays of chlorothalonil were found to be economical which reduced the disease intensity and enhanced the pod yield.

Early sowing of crop (first fortnight of June) is better than late sowing (Second fortnight of July). Early sown crop escaped from the late leaf spot infection, whereas late sown crop suffered much from the disease. The groundnut yield can be predicted in terms of date of sowing and per cent disease index (PDI) at 87 days after sowing with 77 per cent confidence and remaining 23 per cent might have been due to extraneous factors.

Maximum germination of conidia of P. personata was noticed in two per cent glucose, two per cent sucrose and one per cent sucrose solutions when incubated at 27°C respectively.

The conidia remained viable in the host debris for 105 days under natural conditions, for 181 days at 6°C and 151 days under laboratory and glass house conditions.

Considerable increase in total sugar content was observed in diseased leaf in comparison with healthy leaf. Total phenol content was less in diseased leaf than in healthy leaf.

Fungicides viz., mancozeb (Dithane M-45), carbendazim (Bavistin), bitertanol (Baycor), chlorothalonil (Kavach) reduced disease effectively and yield was also increased when compared to plant extracts like sorghum, coconut, parthenium, and neem leaf extracts. However, neem leaf extract was found to increase the yield than the other leaf extracts under study.

Among 12 leading groundnut genotypes screened, only two genotypes viz., PI 393516 and ICGV-872664 were found moderately resistant to the disease, but none of the genotype was found to be completely resistant to the disease.

CHAPTER - VII

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