CHEMICAL CONTROL OF RED RUST OF MANGO

A Thesis

By

ROKSHANA PARVIN
Roll No. 2003. Ag. P. Path. JD-08 M
Registration No. 23405 (1996-'97)
July-December, 2004

MASTER OF SCIENCE
IN
PLANT PATHOLOGY

Department of Plant Pathology
Bangladesh Agricultural University
Mymensingh

December, 2004

CHEMICAL CONTROL OF RED RUST OF MANGO

A Thesis

By

ROKSHANA PARVIN
Roll No. 2003. Ag. P. Path. JD-08 M
Registration No. 23405 (1996-'97)
July-December, 2004

Submitted to
The Department of Plant Pathology
Bangladesh Agricultural University, Mymensingh
in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE
IN
PLANT PATHOLOGY

Department of Plant Pathology
Bangladesh Agricultural University
Mymensingh

December, 2004

CHEMICAL CONTROL OF RED RUST OF MANGO

A Thesis

By

ROKSHANA PARVIN
Roll No. 2003. Ag. P. Path. JD-08 M
Registration No. 23405 (1996-'97)
July-December, 2004

Approved as to style and content by:

Dr. Md. Ayub Ali
Supervisor

Professor Dr. M. A. Rahim
Co-Supervisor

Dr. Md. Ayub Ali
Chairman, Examination Committee
and
Head, Department of Plant Pathology
Bangladesh Agricultural University
Mymensingh

December, 2004

ACKNOWLEDGEMENT

All praises are due to the "Almighty Allah", the Merciful, the Beneficent and the Supreme authority of this universe, Who enabled me to complete research and write up of the thesis on time.

I wish to express heartfelt gratitude, respect, indebtedness and sincere appreciation to my Supervisor, Dr. Md. Ayub Ali, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh for his ingenious and scholastic supervision, intellectual guidance, constructive criticism, valuable suggestions, affectionate feelings and constant encouragement during the entire period of the research work and preparation of the manuscript.

I feel to express my gratefulness and thanks to my Co-supervisor, Dr. M. A. Rahim, Professor, Department of Horticulture, Bangladesh Agricultural University, Mymensingh for his encouragement, affectionate advice and valuable suggestions during the whole study period.

I wish to express my gratitude to Prof. Dr. M. Bahadur Meah, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh for his help, valuable suggestions and affectionate care during the period of my study.

I am deeply indebted and grateful to M. M. R. Jahangir, Lecturer, Department of Soil Science, Bangladesh Agricultural University, Mymensingh for his sympathetic encouragement, affectionate advice, valuable suggestions and constant help throughout the research work.

I feel proud and deeply indebted to my beloved parents, elder sisters, younger brothers and sister, relatives for their affection, love, blessing, sacrifies constant inspiration to complete the research work and write up this manuscript.

I am also grateful to my friends especially Md. Feruz Uddin Ahmed and Munna for their cooperation and good wishes. Finally, sincere thanks are expressed to Md. Abdul Mannan for his careful help in computer compose of this dissertation.

The Author

CONTENTS

CONTENTS (contd.)

CONTENTS (contd.)

CHAPTER 1

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important, popular nutritious fruits grown in the tropical and subtropical countries of the world as well as in Bangladesh. It has been cultivated for more than 4000 years (Candole, 1984; Bose, 1985). It is a perishable crop. Popene (1964) called mango as "the king of oriental fruits". It is widely grown all over Bangladesh. The high quality mangoes are cultivated in the northern areas specially Rajshahi, Dinajpur and Rangpur (Karim, 1985).

Mango ranks third among the tropical fruits grown in the world with a total production of 15 million tons (FAO, 1995). India is the largest producer who produces 9.30 million tons followed by Brazil, Pakistan, Mexico, Sudan, Srilanka and Cuba (Bhuyan, 1995). In Bangladesh mango ranks first in terms of area and third in production. Bangladesh produced 187220 million tons of a mango in 124715 acres of orchard during 2002 (BBS. 2003).

Mango is a popular fruit of the country having some special organoleptic features such as excellent flavours, pleasant aroma, attractive colour and taste. It is a rich source of vitamins, minerals, total soluble solid etc. (Paramanik, 1995). It is also a rich source of vitamin A. Ripe mango pulp contains 16.9% carbohydrate (Salunkhe and Desai, 1984). The green fruits are used for preparation of pickles, chutneys and amchur. Ripe fruits are used for the preparation of squash, nectar, jam, cereal flakes, custard powder, baby food, mango lather (am papar) and toffee (Siddique and Scanlan, 1995).

Mango is subject to a number of diseases at all stages of its growth and development and in storage or transit. Of them stem end rot, anthracnose, powdery mildew, red rust, black spot, scab, soft rot etc. are important. Among them red rust causes significant loss in some varieties such as Amrapali. Red rust is caused by an algae, *Cephaleuros virescens*.

The algal disease of mango has been observed in India and the USA. Its distribution in India has been in Uttar Pradesh, Bihar, Karnatak (Nirvan 1974; Chowdhury, 1975). Now a days this disease is becoming a major problem for mango production in Bangladesh. The incidence of the disease drastically increases due to high temperature, high humidity and 250 cm or more rainfall (Pathak, 1974).

The pathogen affects the leaves and twig of the plant. As a result the affected areas cracke and scale off. The algal infection causes reduction in total protein, ammoniacal compound, nitrite and amino acid content but content of nitrate accumulation in the infected leaves (Pathak, 1963). *Cephaleuros virescens* significantly increases total sugar content of diseased leaves, while decreases chlorophyll content. Avoidance of close planting may be helpful in keeping the disease away. Some chemicals have been tested in India to control the disease such as, Bordeaux mixture, Fytalon, Blitox-50, Cupravit-50 wp, Microthiol-80 wp (Gupta *et al.*, 1980).

No research work has critically been done in Bangladesh on its chemical control measures. In view of above facts, present investigation has been undertaken with the following objectives:

- to evaluate some available chemicals for controlling red rust of mango and
- to estimate the cost benefit ratio of application of different chemicals.

CHAPTER 2
REVIEW OF LITERATURE

Red rust or red spot is a common algal disease on the mango in the "Tarai" and in the other humid region of India and Bangladesh. Its occurrence has been reported in India from Bihar (Yadava, 1953), Mysore (Safeeulla and Govindu, 1948) and Uttar Pradesh (Nirvan, 1974). It has also been reported from Florida (Lynch and Mustard, 1950).

According to Singh (1968) initially the spots of red rust disease on mangoo leaves are greenish-gray in colour and velvety in texture, but later on the surface bears reddish-brown hair-like structures which give it the characteristic red-rust appearance. The algal spot is circular to irregular in shape slightly elevated, and with usually a diameter of 2 mm, though in some cases it may be as much as 1 cm. A number of such spots may be formed on the upper surface of the leaf blade. The spores are produced and released from the algal matrix and remain attached to the leaf surface leaving a creamy white mark at the original rust spot. The parasite can only make headway when the host is growing. Latter when the growth of the host is vigorous, the alga is generally shed off by exfoliation of outer tissues, thus the alga is rare on newly growing shoots.

Singh (1968) found that the thallus of red rust alga of mango is a pseudo-parenchymatous tissues one to several cells in thickness, in which the cells are

radially arranged. A discord mass, which grows just beneath the circular layer of epidermal cells, often has regular branches on its underside. It grows down between the cells of the epidermis and the deeper- lying tissues. The upper surface of the algal mass bears numerous unbranched filaments, which project through the cuticle. Some of these erect filaments are sterile hairs, others bear a cluster of sporangia or gametangia at their apex. Cells of both sterile and fertile hairs are usually reddish-brown.

Singh (1968) further stated that reproduction of red rust algae in mango is by means of zoospores which are formed in sporangia produced at the extremities of fertile hairs. The sporangia are borne in clusters and each lies at the end of short stalk-cell. When mature, the sporangia break away and dispersed by the wind. They produce biflagellate zoospores as soon as they are moistened. If the sporangium is one that has fallen on a leaf or twig of a suitable host, the zoospore may germinate to form a new thallus. There is also formation of biflagellate gametes within a gametingum resulting from enlargement of certain cells in the pseudo parenchymatous portion of the thallus.

Suit and Du Charme (1946) observed that the red rust alga attacks the foliage, bark and twig of the host plant (mango, litchi etc.). They also observed that in serious infections the bark become thickened, the twigs enlarged and remain stunted, the foliage becomes sparse and finally dries up.

Holocomb *et al.* (1998) studied *Cephaleuros virescens* on black berry in Arkansas and Louisiana, found that due to algal infection stem cracking, tissue discoloration and the presence of an orange, velvet like growth that was identified as sporangiophores and sporangia of the parasitic green algae *Cephaleuros virescens*. They also found the disease occurred more commonly on thornless than on thorned type cultivars.

Tiwari and Singh (1999) conducted an experiment at Regional agricultural research station, Sarakanda, Farm, Bilaspur, India in different mango cultivars. They found that 23 mango cultivars were resistant to red rust.

Safeeulla and Govindu (1948) and Yadava (1955) studied some new host of *Cephaleuros* in India and reported that 26 and 47 hosts of algae of red rust from Mysore state and Bihar respectively.

Dulvi and Sardeshpande (1993) conducted an experiment with *Cephaleuros virescens on* mango and found that the alga significantly increased the total sugar content of diseased leaf, but decreased chlorophyll content. He reported Copper oxychloride, Bordeaux mixture, Fytalon and Copper sulphate were effective in controlling the pathogen up to two months but Bordeaux mixture and Copper sulphate solutions had appreciable effect checking the pathogen for long time and Copper sulphate solutions had no adverse effect on mango leaves.

Vidhyasekaran and Parambaramani (1971) studied physiology of the alga infected leaf tissues in mango plant and found that both glucose and sucrose were less while fructose was more in the alga infected tissue. Starch, Cellulose and Pectin were more in infected tissues while lignin content did not change. The algal infection caused reduction in the total protein, ammoniacal, nitrite, amino and amide nitrogen content. Glutamic acid and alanine increased markedly but glycin decreased sharply and valine content did not alter by the algal infection.

Adverse effects of various pathogens on the metabolism of different nutrients and synthesis of chlorophyll in hosts are well known. Vidaysekaran and Parambaramani (1970) reported phenomenal increase in fructose and decrease in glucose and sucrose due to attack of red rust of mango.

Many species of *Cephaleuros* are reported to infect different hosts in all parts of the world. As early as Karsten (1981) reported *Cephaleuros* as a parasites on tree and shrub.

Sardeshpande (1988) experimented with red rust of mango at Regional Fruit Research Station, Vengurla, Sindhudrug and observed the incidence of *Cephaleureos* on 160 varieties of mango.

Many economic plants other than the mango are also attacked by the algae. Citron (*Citrus medica* L.) (Suit and Du Charme, 1946; Yadava, 1955), Tea *(Thea sinensis* L.) (Tunstall and Sarmah, 1947), Guava (*Psidium guajava* L), ber (*Zizyphns mauritiana*), apple (*Malus sylvestris* Mill.) and litchi *(Litchi chinensis* sonn.) (Yadava, 1953; 1955) are some of the common hosts for the algae.

Prakash and Singh (1980) experimented with control of red rust of mango. They tested some chemicals (Bordeaux mixture, Fytalon, Cupravit etc.) and obtained good control of *Cephaleuros virescens.*

Gupta *et al.* (1990) conducted an experiment with control of red rust disease of mango with fungicides and reported that the solution of Copper sulphate @ 0.4, 0.6 and 0.8% did not show any injurious effects on mango leaves even after two sprays given at an interval of one month

Pathak (1973) experimented with *Cephaleuros virescens* on mango and found that avoidance of close plantation may be helpful in keeping the disease and the disease can be checked by spraying Bordeaux mixture (6:6:100), Cupramar, fytalon, blitox-50 or lime sulphur.

Suit and Du Charme (1946) reported that Copper sulphate sprays was quite effective in killing the red rust alga of mango.

Bordeaux mixture or commercial lime sulphur prevents the formation of algal spots on citrus (Fawcett, 1936). These can safely be applied to mango orchard. Prunning and manuring of host trees may also be beneficial.

Vinak and Mander (1994) worked with *Cephaleuros* infection on leaves of litchi plant growing at Pinjore Gardens nears Chandigarh, India and found that *Cephaleuros virescens* occurred on the lower surface of leaves. The alga showed a typical heterotrichus habit consisting of basal disc like thallus on the underside and vertically upward rising branches from its upper side. The thallus was reddish brown in colour and had a velvety appearance. Again diseased leaves were characterized by inwardly directed margins wrinkling and upwardly directed eruptions occurring irregular and resulting in leaf distortion.

Bora (1994) conducted an experiment with *Cephaleuros virescens* on mango. Progressive Horticulture Centre, India and found that rust disease of avocado caused by *Cephaleuros virescens* was observed in Pithoragarh, Uttar Pradesh, India in 1992. He also found that the disease first appeared on older leaves followed by the delicate stem parts as small reddish orange pustules and these spread to many parts of the leaves and gradually increased in size.

Borah *et al.* (1976) worked with biochemical changes in ten leaves after infection with red rust *Cephaleuros virescens* (varigated) and non infected (non-variegated) from the some plant at the Tocklai Experimental Station, Jorhat, India at

15 days interval when the disease was severe. They found that varigated leaves contained more amino acids, amides and soluble sugars than non varigated ones, but less polyphenols, chlorophylls and dry matter and enzyme activity was reduced. They suggested that higher level of tree may stimulate algal development.

Gupta (1992) conducted an experiment about the chemical control of algal rust of litchi by using different types of chemical. He used Copper oxychloride. Bordeaux mixture, Captafol, Mancozeb and Ziran during July-September control rust of Litchi. He found that all fungicides reduced disease caused by *Cephaleuros virescens*. He reported 0.3% Copper oxychloride was most effective followed by 0.2% Captafol and 0.25% Ziran.

Barthakur *et al.* (1992) conducted experiment with clonal susceptibility of red rust of tea using 14 widely used tea (TV) clones at Assam, India. They found that none of these clones were resistant to red rust.

Rao and Ramesh (1987) conducted a survey of disease of cloves (*Syzygium aromaticum*) and black peper (*Piper nigrum*) on the Andaman and Nicobar Island, India during 1987-88. They found that leaf necrosis in pepper and leaf fall in cloves were caused by *Cephaleuros virescens*. They also found that spraying the crops with fungicides may reduce infestation of *Cephaleuros virescens*.

Hsieh (1985) surveyed disease of woody plants in Tiwan and reported that 87 woody species attacked by the algae, *Cephaleuros virescens* in Tiwan.

Kueh *et al.* (1983) conducted a study on black berry and black pepper diseases. They found that the local cultivar of *Pipper nigrum,* kuching was highly susceptible to this disease. Among 17 fungicides evaluated, Bavistin, Benlate and Derosal increased green berry yield and reduced the number of black spots. Other promising fungicides include Bayleton (Triadimefon), Difolatan (Captafol), Manzate (Menab + Zn), Mk 23 and Topsin M.

Hiseh (1983) noted that host plants of *Cephaleuros virescens* include 64 plant species dispersed in 33 families and 52 genera. Sexana *et al.* (1978) reported that *Xylosana longifolium* is a new host for the parasitic alga (*Cephaleuros virescens*) found Dehra Dun, India. Joshi *et al.* (1978) observed that brown rust of grape is caused by *Cephaleuros parasiticus* [*C. virescens*] and it affected several cultivars in Gorakhpur.

Chakravarty and Mishra (1983) studied host range of *Cephaleuros virescens.* They recorded 49 hosts in Meghalay, India of which 26 were new records. It was common on angiosperm but did not occur on gymnosperms. The disease was severe in summer and in rainy season.

Kabir and Meah (1987) sprayed guava plants in Horticulture base, Keyothkali in 1986 prior to symptoms appearance with Dithane M-45, Topsin M, Cupravit, Dithane Z-78 and Rovral ELO. They found an excellent control of the fruit infection with 5 sprays of Topsin M, Rovral ELO and Dithane Z-78.

CHAPTER 3

MATERIALS AND METHODS

3.1 Experimental site

The experiment was conducted at Germplasm Centre of Fruit Tree Improvement Programme (FTIP), Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period of September 2003 to July 2004.

3.2 Topography and soil

The topography of land was medium high and soil was clay loam in texture having pH around 5.5-6.8. Soil colour was dark grey due to rich in organic matter content.

3.3 Climate

The experimental area is under subtropical climate, characterized by comparatively high rainfall, high humidity, high temperature, short clear sunshine during April to September. There was scanty rainfall, low humidity and low temperature, short day and long clear sunshine during October to March. Details of the weather data were collected from weather yard, Department of irrigation and Water Management, Bangladesh Agricultural University, Mymensingh, are presented in Appendix-1.

3.4 Treatments

There were five treatments designated by T_0, T_1, T_2, T_3 and T4 which were as follows:

T_0 = Control

T_1 = Cupravit-50 wp

T_2 = Bordeaux mixture

T_3 = Microthiol-80 wp

T_4 = Mobil-soap-suspension

3. 5 Design of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications for each treatment.

3.6 Lay out of the experiment

Mango plants were planted following hexagonal system of planting plan. The experiment was conducted with a mango cultivar Amrapali. Grafts were sown as planting materials. The age of the plants were 5 years, at the time of conducting this experiment. The height of plant was medium (5.6-8.0 ft).

3.7 Preparation of Bordeaux mixture

Ten grams of $CuSO_4.5H_2O$ was dissolved in 500 ml water in an earthen vessel and 10 grams of $Ca(OH)_2$ was dissolved in 500 ml water in another earthen vessel. The vessels were then kept undisturbed for 24 hours. The spray suspension was then prepared by simultaneous method and sprayed in three plants.

3.8 Preparation of Microthiol-80 wp solution

The spray solution of this fungicide was prepared by dissolving 4.55 grams of Microthiol-80 wp in one litre distilled water and mixed thoroughly. This spray solution sprayed in three plants.

3.9 Preparation of Cupravit- 50 wp solution

The spray solution of the fungicide was prepared by dissolving 7.44 grams of Cupravit-50 wp in one litre distilled water and then mixed well. This spray solution sprayed in three plants.

3.10 Preparation of Mobil-soap-suspension

Fifteen grams soap (Londri) was soaked in one litre distilled water for 24 hours. This suspension was mixed with 200 ml used Mobil. The mixture was then shaken to prepare a well dispersed suspension. This spray solution sprayed in three plants.

3.11 Application of spray solution

Required amount of spray solution of Bordeaux mixture, Microthiol-80 wp, Cupravit-50 wp and Mobil-soap-suspension prepared as mentioned above were sprayed as test treatment on the selected plants. The test chemicals were sprayed thrice at 30 days interval. Freshly prepared solution/suspension were used as spray solution. Adequate precautions were taken to avoid drifting of spray materials from one plant to another plant. Special attention was given to complete coverage of the plants with the spray solution.

3.12 Intercultural operation

Weeding, mulching and irrigations were done twice each during study period. No other pesticides such as insecticide or nematicides were used in the test plants.

3. 13 Data collection

a. Number of healthy branches per plant

The total number of healthy branches of each plant were counted. These data were recorded at one month interval.

b. Number of infected branches/plant

The total numbers of diseased branches were counted at one month interval.

c. Number of healthy leaves per 10 branches of a plant

Ten healthy leaves were counted from each of the ten branches from each of the plant. These data were recorded at one month interval.

d. Number of diseased leaves per 10 branches of a plant

Ten diseased leaves were counted from each of the ten branches from each of the plant. These data were recorded at one month interval.

e. Number of spots per diseased leaf

Total number of spot per diseased leaf was counted from ten leaves from each of the plants. These data were recorded at one month interval.

f. Size of spot (mm)

The size of spot of 10 selected leaves per treatment was measured by millimeter scale.

g. Percent diseased leaf area

Data on diseased leaf area were recorded from ten branches of each plant at ten infected leaves.

h. Number of fruits per plant

Number of fruits per plant were counted during ripening stage.

i. Fruits weight (kg)

After harvest weight of 20 fruits per plant were recorded with the help of a balance. Average weight of individual fruit was calculated. The weight of individual fruit obtained in different treatments was compared.

j. Fruit yield

The fruits were harvested from the plants. The weight (kg) of all mangoes in each treatment was recorded. The weight of all fruits was considered as total yield in each treatment.

k. Cost-benefit ratio

Number of labours required for (solution) preparation and spraying of spray solution was recorded. Labour cost was calculated on the basis of 8 working hours per day. Amount of fungicide and its cost was also calculated. Price of the yield of

mango obtained from different treatment was calculated based on market price. The benefit-cost analysis was done following the method of Mondal *et al.* (1994). The benefit-cost ratio was then calculated by using the following formula:

$$BCR = \frac{\text{Gross Return} - \text{Cost}}{\text{Cost}}$$

3.14 In Vitro test

a. Isolation, purification and identification of the organism

Diseased leaf with typical symptom was collected for isolation of the organism in the Laboratory. Potato Dextrose Agar (PDA) media was prepared and transferred to glass petridishes. The leaf samples were cut into small pieces. Each pieces contained diseased and healthy tissue. Surface sterilization of the pieces with spirit (1%) for 1 minute was done followed by two washes with sterile water. The plates were incubated at 28 ± 2^0C for growth of algae.

The algae which grew in PDA plates transferred to another set of PDA by tip culture method. In this method, 1 mm blocks of algal colony from the periphery were collected from the culture plates and placed on PDA plates at one block one plate. The block was at the center of the plate. Colony characters, linear growth, colour and sporulation of the algae was studied following the methods of Singh (1982).

b. Microscopic study

The presence of *Cephaleuros virescens* was confirmed through direct slide preparation from the symptoms of leaves in the laboratory. The upper surface of the spot consists of numerous, unbranched filaments which project through the cuticle. Some of the filaments represent sterile hairs while others the fertile ones. The latter bear cluster of spores at the apex. Cells of both the types of hairs and mature spores are brown-coloured (Pathak, 1973).

3.15 Statistical analysis

The recorded data on different parameters were subject to statistical procedure for analysis of variance. Significance of difference of means were done by Least Significant Difference (LSD') following the procedure as described by Gomez and Gomez (1984). MSTAT computer software programme was used for statistical analysis.

Figure 1: Typical symptom of red rust of mango

Figure 2: Alga mass growth of *Cephaleuros virescens* on PDA cultured from infected mango leaves

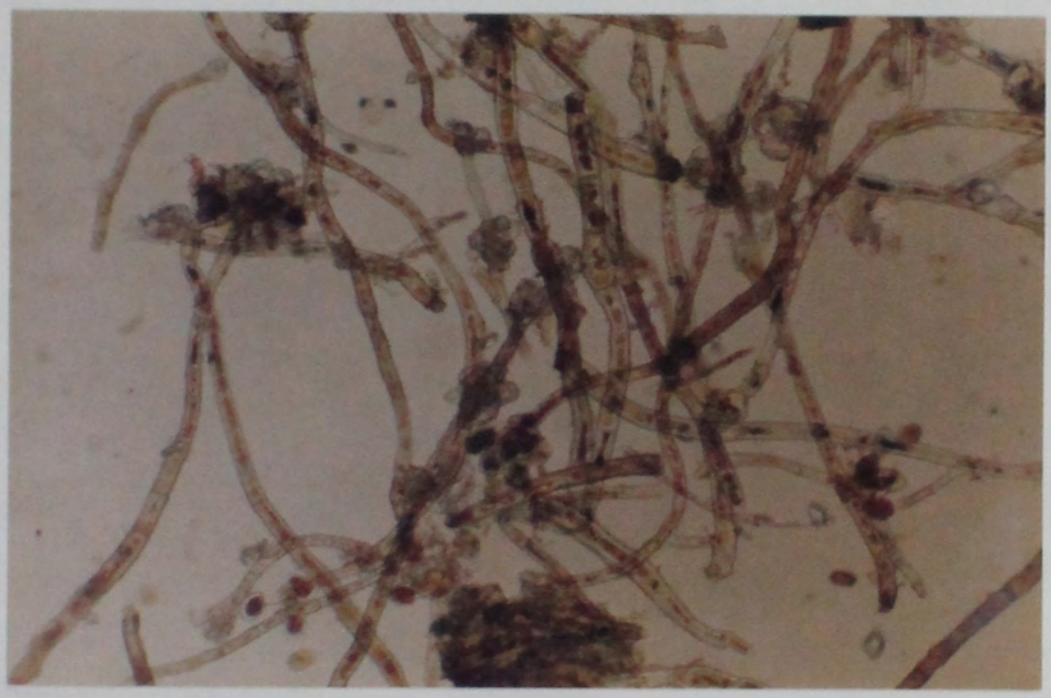

Figure 3: Different structure of alga mass of *Cephaleuros virescens* from infected mango leaves

4.3 Effect of different treatment on number of healthy branches per plant

The effects of different treatments on number of healthy branches per plant were determined at 30 days intervals and presented in Table-1. Before application of chemicals the number of healthy branches were 12.66, 13.00, 14.33, 12.66 and 12.00 in T_0, T_1, T_2, T_3 and T_4 respectively.

After application of first spray. (30 DAFS) there was significant difference among the treatments in respect of number of healthy branches/plant. The number of healthy branches was maximum (17.00) in case of T_2 (Bordeaux mixture) and minimum (11.33) in T_0 (control). The respective number of healthy branches were 15.00, 14.00 and 13.00 in T_1 (Cupravit-50 wp), T_3 (Microthiol-80 wp) and Mobil-soap-suspension.

After application of second spray (60 DAFS), the highest number of healthy, branches (19.33) were recorded in T_2 (Bordeaux mixture) and lowest (10.00) in T_0 (control). Number of healthy branches was comparatively higher in T_1 (Cupravit-50 wp) then T_3. It was statistically similar in T3 and T4.

Significantly different number of healthy branches were counted after third spray (90 DAFS). The highest number of healthy branches (21.66) was recorded in T_2, (Bordeaux mixture). The effect of T_1 (Cupravit-50 wp) and T_3 (Microthiol-80 wp) were statistically similar. The lowest number of healthy branches (9.33) was recorded in To (control.).

Table 1. Effect of different treatments on number of healthy branches/plant

Treatment	Before spray	Days after first spray (DAFS)		
		30	60	90
T_0	12.66	11.33c	10.00d	9.33e
T_1	13.00	15.00b	13.33b	17.00b
T_2	14.33	17.00a	19.33a	21.66a
T_3	12.66	14.00c	15.00bc	16.00c
T_4	12.00	13.00d	14.00c	14.00d
% CV	-	3.18	7.02	3.96

Means followed by the same letter in a column did not differ significantly at 5% level by DMRT

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4 = Mobil-soap-suspension

4. 4 Effect of different treatment on number of infected branches per plant

The effects of different treatments on number of infected branches (diseased) per plant were determined and presented in Table 2. Before application of chemicals the number of infected branches were 10.33-11.33 in different treatments.

There was significant differences among the treatments in respect of number of infected branches after application of first spray (30 DAFS). The highest number of infected branches (12.66) were in T_0 (control) and lowest (7.33) in T_2 (Bordeaux mixture). T_3 (Microthiol-80-wp) and T_4 (Mobil-soap-suspension) were statistically similar.

The highest number (13.00) of infected branches/plant were observed in T_0 (control) after application of second spray (60 DAFS). This was followed by T_4 and T_3. The lowest number of infected branches/plant was found in T_2 (Bordeaux mixture).

Maximum number of infected branches/plant (14.00) was found in control after application of third spray (90 DAFS). The minimum number (3.33) of 'infected branches/plant was found in T_2 (Bordeaux mixture). T_3 and T_4 were statistically similar.

Figure 4. Leaves of healthy plants

Figure 5. Severity of red rust disease in control plants

Table 2. Effect of different treatments on number of infected branches/plant

Treatment	Before spray	Days after first spray (DAFS)		
		30	60	90
T_0	11.00	12.66a	13.00a	14.00a
T_1	10.33	8.33c	7.66d	7.00c
T_2	10.33	7.33d	6.33e	3.33d
T_3	11.33	9.66b	8.66c	8.33b
T_4	10.33	9.66b	9.66b	9.33b
% CV		4.83	5.08	6.52

Means followed by the same letter in a column did not differ significantly at 5% level by DMRT

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4 = Mobil-soap-suspension

4.5 Effect of different treatments on number of healthy leaves/10 branches of a plant

Comparative effects of different chemicals on number of healthy leaves/10 branches of a plant are presented in Table-3. Before application of chemicals the number of healthy leaves were 150.31, 161.3, 160.7, 155.3 and 159.7 in T_0, T_1, T_2, T_3 and T_4 respectively.

After application of first spray (30 DAFS) the highest number of healthy leaves (175.3) was recorded in T_2 (Bordeaux mixture), and lowest number was found in T_0 (control). The number of healthy leaves were similar in T_3 (163.7) and T_4 (163.3). It was higher inT_1 than in T_3 and T_4.

The highest number of healthy leaves (193.7) was found in T_2 (Bordeaux mixture) and lowest (133.7) in T_0 (control) after application of second spray (60 DAFS). T_1 was higher than T_3. T_3 and T_4 were statistically similar.

After application of third spray (90 DAFS), the highest (201.70) number of healthy leaves/10 branches of a plant was recorded in T_2 (Bordeaux mixture) and lowest (125.7) in T_0 (control) treatment. T_1 is comparatively better than T_3 and T_4 in respect of number of healthy leaves.

Table 3. Effect of different treatments on number of healthy leaves/10 branches of a plant

Treatment	Before spray	Days after first spray (DAFS)		
		30	60	90
T_0	150.30	141.30c	133.10d	125.70d
T_1	161.30	170.00ab	184.30ab	198.30a
T_2	160.70	175.30a	193.70a	201.70a
T_3	155.30	163.70b	181.30bc	188.30b
T_4	159.70	163.30b	170.70c	178.70c
% CV	-	4.94	3.38	3.28

Means followed by the same letter in a column did not differ significantly at 5% level by DMRT

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4 = Mobil-soap-suspension

4.6 Effect of different treatments on number of infected leaves/ 10 branches of a plant

The effects of different treatments on number of infected leaves/10 branches of a plant are shown in Table 4. Before application of chemicals the infected leaves/10 branches of a plant were recorded 68.66-80.83 in different treatment.

After application of first spray (30 DAFS), the highest number of (89.33) infected leaves/10 branches of a plant were observed in T_0 (control) and lowest (56.66) in T_2 (Bordeaux mixture). T_1 and T_3 were statistically similar.

The highest number (97.00) of infected leaves/10 branches of a plant were recorded in T_0 (control) and lowest in T_2 (Bordeaux mixture) after application of second spray (60 DAFS). T_1 and T_3 were statistically similar and better than T_4.

After application of third sprays (90 DAFS), the highest number (105.0) of infected leaves/10 branches of a plant was recorded in T_0 (control) and lowest number (34.66) was recorded in T_2 (Bordeaux mixture). T_1 and T_3 are statistically similar.

Figure 6. Severity of red rust disease in Bordeaux mixture treated plants

Figure 7. Severity of red rust disease in Cupravit-50 wp treated plants

Figure 8. Severity of red rust disease in Microthiol-80 wp treated plants

Figure 9. Severity of red rust disease in Mobil-soap-suspension treated plants

Table 4. Effect of different treatments on number of Infected leaves/10 branches of a plant

Treatment	Before spray	Days after first spray (DAFS)		
		30	60	90
T_0	80.33	89.33a	97.00a	105.00a
T_1	70.33	62.66d	54.33cd	43.00cd
T_2	68.66	56.66c	45.66d	34.66d
T_3	75.66	67.33c	57.66c	50.33c
T_4	78.33	74.66b	67.33b	60.66b
% CV	-	2.99	7.25	7.61

Means followed by the same letter in a column did not differ significantly at 5% level by DMRT

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4 = Mobil-soap-suspension

4.7 Effect of different treatments on number of spots/leaf

Comparative effect of different treatments on number of spots/leaf are shown in Table-5. Before application of chemical number of spots /leaf were 55.33- 61.33 different treatments.

After application of first spray (30 DAFS), the highest number of spots were recorded in T_0 and lowest number in T_1 and T_4. T_2 and T_3 were statistically similar.

The highest number of spots (72.00) per leaf were recorded in T_1 and lowest (64.25) in T_2 were observed after application of second spray (60 DAFS). After application of third spray the number of spots/leaf increases significantly. During this period the highest number of spot were recorded in control (T_0) Which were 64.66, 72.00 and 81.66 respectively.

On the contrary, during this period, the lowest number were recorded in T_2 (Bordeaux mixture) which were 63.33, 64.25 and 64.35 respectively. T_1 always better performance than T_3 in number of spots/leaf.

Table 5. Effect of different treatments on number of spots/leaf

Treatment	Before spray	Days after first spray (DAFS)		
		30	60	90
T_0	55.33	64.66a	72.00a	81.66a
T_1	59.00	61.33c	65.66c	68.00c
T_2	51.33	63.33bc	64.25c	64.35d
T_3	58.66	62.66bc	66.30bc	70.35bc
T_4	56.33	61.39c	68.29b	73.15b
% CV	-	1.85	3.61	2.65

Means followed by the same letter in a column did not differ significantly at 5% level by DMRT

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4 = Mobil-soap-suspension

4.8 Effect of different treatments on spot size/spot (mm)

The comparative effect of different treatments on spot size/spot recorded at 30 days intervals are presented in Table-6. Before application of chemicals spot size /spot were 3.30, 3.25, 3.28, 3.29 and 3.32 in T_o, T_1, T_2, T_3 and T_4 respectively.

After application of first spray all data were non-significant. The highest spots size/spot was maximum (3.78) in T_o (control) and minimum (3.39) in T_2 (Bordeaux mixture) after application of second spray (60 DAFS).

Highest spots size (4.35) was in T_0 (control) and lowest (3.42) in T_2 (Bordeaux mixture) after application of third spray. T_1 and T_3 were statistically similar and better than T_4.

4.9 Effect of different treatments on percent diseased leaf area (%DLA)

Comparative effect of different treatments on percent diseased leaf area (%DLA) are presented in Table-7. Before application of chemicals percent diseased leaf area were 1.190, 1.220, 1.108, 1.112 and 1.124 in T_0, T_1, T_2, T_3 and T_4 respectively. After application of first, second and third spray % DLAs were significantly increased. During these (after application of first, second and third spray) periods, the highest %DLA were recorded control (T_0) which were 3.202, 6.50 and 9.32 respectively. This DLA (%) were not statistically similar to other treatments. On the contrary during these periods, the lowest DLA (%) were recorded in T_2, (Bordeaux mixture). The recorded DLA were 1.98, 2.5 and 3.1 respectively. T_1 and T_3 were statistically similar.

Table 6. Effect of different treatments on spot size/plot

Treatment	Before spray	Days after first spray (DAFS)		
		30	60	90
T_0	3.300	3.50a	3.78a	4.05a
T_1	3.25	3.38a	3.72b	3.68c
T_2	3.28	3.31a	3.39c	3.42d
T_3	3.29	3.39a	3.40b	3.63c
T_4	3.32	3.41a	3.53b	3.70b
% CV	-	5.74	1.28	5.47

Means followed by the same letter in a column did not differ significantly at 5% level by DMRT

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4=Mobil-soap-suspension

Table 7. Effect of different treatments on diseased leaf area (% DLA)

Treatment	Before spray	Days after first spray (DAFS)		
		30	60	90
T_0	1.19	3.20a	6.50a	9.32a
T_1	1.22	2.30bc	3.53c	4.50c
T_2	1.11	1.98c	2.50d	3.15d
T_3	1.11	2.50bc	4.10c	5.20c
T_4	1.12	2.70ab	5.21b	6.52b
% CV	-	14.11	8.22	8.71

Means followed by the same letter in a column did not differ significantly at 5% level by DMRT

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4=Mobil-soap-suspension

4.10 Effect of different treatments on fruit weight/plant (kg) and number of fruits/plant

Data on the fruit weight of mango as influenced by different chemicals are presented in Table-8. Maximum fruit weight (36.2 kg) was obtained from T_2 (Bordeaux mixture) followed T_1 (Cupravit-50 wp). Minimum fruit weight (7.26 kg) was found in T_2 (control). From T_3 (Microthiot-80 wp) and T_4 (used Mobil-soap-suspension) fruit weight was recorded 16.37 kg and 13.27 kg respectively which were statistically similar.

Number of fruit/plant was recorded which was also shown in Table-8. Maximum number (90.50) of fruits were recorded in T_2 (Bordeaux mixture) and lowest number (38.6) recorded in T_0 (control). T_1 was comparatively better than T_3.

Table 8. Effect of different treatments on fruits weight (kg) per plant and number of fruits/plant

Treatment	Fruit wt. (kg/treat.)	No. of fruit/plant
T_0	7.26d	38.6e
T_1	24.35b	75.87b
T_2	36.2a	90.50a
T_3	16.37c	62.73c
T_4	13.27c	53.09d
% CV	10.76	7.13

Means followed by the same letter in a column did not differ significantly at 5% level by DMRT

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4=Mobil-soap-suspension

4.11 Cost benefit analysis of different chemicals

Cost benefit analysis of different chemicals in controlling red rust of mango has been estimated and showed in Table-9. The highest yield (36.2 kg) was obtained from Bordeaux mixture followed by Cupravit- 50 wp (24.35). Lowest yield (7.26 kg) was found in control treatment. The average yield of other treatments were 16.37 and 13.27 kg Microthiol-80 wp and Mobil-soap-suspension.

Gross return was maximum (Tk 1629.00) in T_2 (Bordeaux mixture) treated plants and minimum gross return (326.7) was found in T_0 (control) treated plant. Total cost of labour for chemical preparation and spray in an average and cost of chemical Tk 270, Tk 280, Tk 250, Tk 240 in T_1, T_2, T_3 and T_4 respectively. The highest gross margin was obtained Tk. 1349.00, in Bordeaux mixture followed by Cupravit-50 wp (Tk 825.75) over the control. Minimum gross margin was found in control (Tk 326.70).

Table 9. Cost benefit analysis of different chemicals in controlling red rust of mango

Treatment	Average yield kg/treatment	Gross return (Tk)	Total cost (labour+ fungicide) Tk	Gross margin (Net return) Tk
T_0	7.26	326.70	-	326.70
T_1	24.35	1095.75	270.00	825.75
T_2	36.2	1629.00	280.00	1349.00
T_3	16.37	736.65	250.00	486.65
T_4	13.27	597.15	240.00	351.15

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4=Mobil-soap-suspension

4.12 Benefit cost ratio (BCR) of different chemicals

It has been found that use of different chemicals 3.03, 4.8, 1.95, 1.46 BCR in T_1, T_2, T_3, and T_4 respectively are shown in Table- 10. Among the chemicals Bordeaux mixture showed highest (4.8) BCR over control followed by Cupravit-50 wp (3.05). incase of control, the BCR value was zero. The results indicated that a return of profit upto Tk 4.8 and can be obtained by investigating Tk1.0 in application of Bordeaux mixture. On the other hand use of control resulted no profit.

Table 10. Benefit cost ratio (BCR) of different chemicals in controlling red rust of mango

Treatment	Average yield kg/treatment	Gross return (Tk)	Total cost (labour+ fungicide) Tk	Gross margin (Net return) Tk	BCR
T_0	7.26	326.70	-	326.70	-
T_1	24.35	1095.95	270.00	825.75	3.05
T_2	36.20	1629.00	280.00	1349.00	4.80
T_3	16.37	736.65	250.00	486.65	1.95
T_4	13.27	597.15	240.00	351.15	1.46

T_0 = Control
T_1 = Cupravit-50 wp
T_2 = Bordeaux mixture
T_3 = Microthiol-80 wp
T_4=Mobil-soap-suspension

CHAPTER 5
DISCUSSION

Severe infection of red rust alga was observed in foliage, bark and twig of mango plants which reduced the growth and development of plants. Four chemicals viz. Cupravit-50 wp, Bordeaux mixture, Microthiol-80 wp. and Mobil-soap-suspension were sprayed three times to evaluate their effect for controlling *Cephaleuros virescens*, the causal alga of red rust of mango.

All test chemicals significantly influenced the number of healthy branches/plant. The highest number of healthy branches/plant were recorded in Bordeaux mixture treated plant. The lowest number of healthy branches were recorded in control treatment. These results were in accordance with the findings of Fawcett (1936). The effects of the Cupravit-50 wp and Microthiol-80 wp were statistically similar. The best performance of Bordeaux mixture to control infection of leaves might be attributed to the controlling effect of Bordeaux mixture on algal growth and development.

All the chemicals significantly reduced the number of infected branches/plant over control. Among the treatments the highest (12.66) and the lowest (3.33) number of infected branches were recorded in control and Bordeaux mixture treated plant respectively. Bordeaux mixture showed better performance over the other treatments. The effects of Microthoil-80 wp and Mobil-soap-suspension were statistically similar. The same effects were observed in all the three application of spray. These results were supported by Pathak (1963).

In all the three applications the highest number of healthy leaves were found in Bordeaux mixture treated plant followed by Cupravit-50 wp, Microthiol-80 wp and Mobil-soap-suspension. The effects of Microthiol-80 wp and Mobil-soap-suspension were statistically similar.

Among the chemicals Bordeaux mixture showed the best performance in respect of disease control in leaves. The lowest number of infected leaves were recorded in those plants which were treated with Bordeaux mixture (Table 4). Pathak (1963) reported that red rust can be checked by spraying Bordeaux mixture (6:6:100). In India another experiment was conducted by Dulvi (1993) and reported that Bordeaux mixture and copper sulphate solutions have appreciable residual effects for checking the alga for long time. This pathogen reduced the chlorophyll content of mango leaves, which causes severe problem to the growth of plants.

The effects of different treatments showed significant influence on number of spots on leaves, Among the chemicals Bordeaux mixture showed the best performance to control the increase of number of spots/leaf followed by the treatments Cupravit-50 wp, Microthiol-80 wp and Mobil-soap-suspension. Borah *et al.* (1978) reported that the varigated leaves contained more amino acid amides and soluble sugars than non-varigated ones, but less polyphenols, chlorophyll and dry matter. The contents of higher among of sugars enhanced the algal growth.

The size of spots were also significantly affected by the different chemicals after the second and third sprays. Thirty days after the first spray showed no significant difference among the treatments Bordeaux mixture was found the most effective chemical for controlling red rust. The effects of the treatment Microthiol-80 wp and Cupravit-50 wp were statistically identical. Similar results were observed by Prakash and Singh (1980) and Gupta *et al.*(1980) . The highest spot size was observed in control treatment.

All the treatments significantly reduced the percent diseased leaf area (% DLA) over the control. But complete control of the disease could not be achieved even after the three sprays due to systemic nature of the disease. Among the chemicals the lowest %DLA was observed Bordeaux mixture treated plant in all the three sprays. In all sprays the highest DLA was found in control treatment. Bordeaux mixture effectively reduced the percent diseased leaf area. This might be attributed to the control of number of spots and size of spot effectively.

Bordeaux mixture was more effective for controlling the red rust of mango than the Cupravit-50 wp, Microthiol 80-wp and Mobil-soap-suspension. The highest fruit weight/plant was found in Bordeaux mixture treatment followed by Cupravit-50 wp, Microthoil-80 wp and Mobil-soap-suspension. In every spray control gave the lowest fruit weight/plant. This might be happened due to the controlling effects of Bordeaux mixture on the growth and development of the red

rust algae. It controlled the infection in leaves and reduced the number of spots, spot size and percent diseased leaf area.

Number of fruits/plant were found to be the highest in these plants which were treated by Bordeaux mixture and were lowest in those plants which were not treated with any chemicals. This indicates that the chemical had significant effects on the disease development and Bordeaux mixture was the best one among them.

In the present experiment, it has been found that all the treatments resulted significant effect on the yield of mango. Bordeaux mixture gave the highest yield (36.2 kg/treatment) followed by Cupravit-50 wp (24.35 kg/treatment), Microthiol-80 wp (16.37 kg/treatment) and Mobil-soap-suspension (13.27 kg/treatment). The lowest yield was found in control. Findings of the present investigation indicated the chemical treated plants showed positive effect on the above mentioned yield components of mango. Due to algal infection the chlorophyll content of plants are assumed to be drustically reduced which caused the premature drop of leaf and ultimately the growth and development of plants are hampared seriously.

The results of cost-benefit analysis among the different treatments showed that the highest gross margin of TK 1349.00 was obtained by spraying plants with Bordeaux mixture followed by Cupravit-50 wp of Tk. 825.7. The treatment Microthiol-80 wp gave the minimum gross margin of Tk. 486.65 which was only 32.86% higher than the control.

Considering the Benefit-cost ratio it is found that Bordeaux mixture resulted the highest benefit-cost ratio (4.8) followed by Cupravit-50 wp, Microthiol-80 wp and Mobil-soap-suspension.

From the above discussion it is evident that among all the chemicals Bordeaux mixture was found to be most effective chemical for control of red rust algae of mango. Cupravit-50 wp may be advised to the farmers for controlling red rust of mango.

CHAPTER 6

SUMMARY AND CONCLUSION

A field experiment was conducted at Germplasm Centre (GPC) of Fruit Tree Improvement Programme (FTIP), Department of Horticulture, Bangladesh Agricultural University, Mymensingh, during the period from September 2003 to July 2004 to evaluate the efficacy of four chemicals used as foliar spray in controlling red rust disease of mango and cost-benefit analysis of mango production. The factorial experiment was conducted in Randomized Complete Block Design (RCBD) with the three replications. The experiment laid out the five treatments viz. T_0 (control), T_1 (Cupravit-50 wp), T_2 (Bordeaux mixture), T_3 (Microthiol-80 wp) and T_4 (Mobil-soap-suspension). The effect of chemicals were compared by Duncan's Multiple Range Test (DMRT).

Among the different treatments, the best over all control of red rust of mango was in Bordeaux mixture treatment. This treatment increased 51.15% healthy branches/plant and 25.72% healthy leaves/10 branches of a plant. On the other hand it reduced 40.92% infected branches of a plant and 46.92% infected leaves/10 branches of a plant. The second best control was found in Cupravit-50 wp. This increased a significant percent of healthy branches/plant and healthy leaves/10 branches of a plant which were 24%, 45% and 34.25% respectively.

mentioned character were also superior to the control treatment. No. of spots/leaf 47.58% increase in Bordeaux mixture. Spot size/spot increase 24.28% in control and 4.40% increase in Bordeaux mixture. Considering fruit weight and number of fruits/plant, maximum were found in Bordeaux mixture and minimum was found in control. Maximum fruit weight was 36.2 kg/treatment and no. of fruit/ plant was 9.50. Minimum fruit weight and no. of fruits were 7.26 kg/treatment and 38.6 respectively.

In cost benefit analysis the highest gross margin of Tk 1349.00 was found in Bordeaux mixture which was showed highest (4.8) BCR over control. The next highest gross margin of Tk 825.75 was found in Cupravit-50 wp which was showed higher (3.05) BCR over control.

However, the findings of the present studies pointed out that Bordeaux mixture showed best performance for controlling red rust of mango. Cupravit-50 wp and Microthiol-80 wp also gave satisfactory result and may also be prescribed the farmers for controlling red rust of mango.

REFERENCES

Ahmed, H. U., Hossain, M. M., Huq, M. I., and Hossain, M. 1991. Efficacy of different fungicides in controlling anthracnose and shooty mould of mango. Bangladesh J. Agril. Res. 16 (1): 74-78.

Arnon, D. I. 1949. Copper enzyme in isolated chloroplast. Polyphenol oxydase ini Beta velgaris. Pl. Physiol., 24:1-15.

Barthakur, B. K., Dutta, P. and Karnan Singh. 1992. Clonal susceptibility of red rust. Plant Protection 39 (2): 52.

BBS, 2003. Monthly Statistical Bulletin. Bangladesh Bureau of statistics. Planning Division. Ministry of' Planing. Government of the peoples Republic of Bangladesh, Dhaka. p. 58.

Bhuyan, M. A. J.1995. Mango (*Mangifera indica*) International Fruit Production Mannual, Horticulture Research Development Programme..pp. 1-286.

Bora, S. S. 1994. Avocado rust, a new record from India. Prog. Hort. 26 (1/2): 85-86.

Borah, R. C., Bajaj, K. L., Bhatia, I. S. 1976. Biochemical Changes in tea leaves infection with red rust (*Cephaleuros parasiticus*). Phytopathologische Zeitschrift. 93 (3): 208-217.

Bose. T. K. 1985. Fruits of India-Tropical and Subtropical. Naya Prokash, Calcutta-6, India. p. 69.

Candole, A. D. 1984. Origin of cultivated plants. Vegal Paul Trench and Co. London. pp. 1-67.

Chakravarity, P. and Mishra, R. R. 1983. Studies in forest Pathology V. Host range of *Cephaleuros virescens* kunge and the biochemical changes of the infected leaves. J. Forest Path. 13 (2): 109-125.

Choi, Y., Lee, H. H. and So, I. Y. 1996. Effects of chemicals on growth of *Pythium aphanidermatum* causing rhizome rot of ginger and inhibition of the disease development. Korean J. Pl. Path. 12 (3): 331-335.

Chowdhury, S. R. 1975. Algal disease of mango. Indian Phytopath. 28: 261-262.

Dulvi, M. N. and Sardeshpande, J. S. 1993. Studies on Red Rust disease of Mango. J. Maharastra Agril. University. 18 (2): 199.

FAO, 1995. Production Yearbook. Statistical Series No. 142. Food and Agriculture organization, Rome, Italy. p. 163.

Fawcett, H. S. 1936. Citrus diseases and their control. McGruw. Hill Publishing Co. New York. 271 P.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures Agricultural Research, 2nd Edn. John Willey and Sons., New York. pp. 97-111.

Gupta, J. H., 1992. Chemical control of algal rust of litchi caused by *Cephaleuros virescens*. kunze. J. Prog. Hort. 24 (1-2): 109-110.

Gupta, J. H., Shrivastava, V. P. and Pandy, I. C. 1980. Control of red rust disease of mango with fungicides. Indian J. Mycol. P1. Path. 10 (2): 61.

Holocomb, G. E., Vann, S. R. and Buckley, J. B. 1998. *Cephaleuros virescens* in Arkansas and its occurrence on cultivated black berry in Arkansas and Louisiana. Plant Disease. 92 (2): 263.

Hsieh, H. J. 1983. Notes on host plants of *Cephaleuros virescens* for Taiwan. Botanical Bulletin of Academia Sinica. 24 (1): 89-96.

Hsieh, H. J. 1985. Survey of disease of woody plants in Tiwan. Algal spot caused by *Cephaleuros virescens* Bull.Tiwan Forest Res. Inst. p. 9.

Joshi, R. D., Prakash,. J. and Dubey, L. N. 1978. Brown rust-a threat to grape cultivation. Curr. Sci. 47 (14): 5 16-5 17.

Kabir,I. M. and Meah, M. B. 1987. Anthracnose of guava and possibility of its chemical control. 12th conference. Bang. Assoc. Advance of Sec. Abstr.No.-23 (1): 122-123.

Karim, A. 1985. Post-harvest problem and prospect of mango in Bangladesh proceedings, 4th National Symp. of Bangladesh Soci. Hort. Sci., pp.130-137.

Karsten, G. 1981. Untersuchungen uber die families der chroolepideen. Ann. Jard. Bot. Buitenzorg, 10: 1-65.

Kirtikar, K. R. and. Basu, B. D. 1918. Indian Medicinal Plants. Lalit Mohan Basu. Allahabad, India.650p.

Kueh, T. K., Othmans, F, Chih, C. P. 1983. A study of black berry disease control in black pepper. Malaysian Agril. J. Sarawak. Malaysia 53 (1): 20-28.

Lynch, S. J. and Mustard, M. J. 1950. Mangoes_in Florida. Department of Agric. Bulletin135 p.

Mckinney, H. H. 1923. Influence of soil temperature and moisture on infection of wheat seedlings by *Helrninthosporium sativum.* J, Agric. Res 2 6:195-217.

Mondal, N. A., Asaduzzaman, S. M., Malaker, P. K., Rouf, M. A. and Huq, M.I. 1994. Evaluation of fungicides against Bipolaris Leaf blight of wheat (*Triticum aestivum* L.) Annals of Bangladesh Agric. 4 (1): 37-40.

Nirvan, R. S. 1953. Bunchy top of young mango seedlings. Indian J. Sci. Cult. 18: 335.

Nirvan. R. S. 1974. Disease of mango in Horticulture in Uttar Pradesh (Souvenir). All India seminar on mango and mango culture, Lucknow. pp. 73-78.

Paramanik, M. A. J. 1995. Effect of different post harvest treatments on physico-chemical changes during storage and shelf life of mango. An M. S. thesis Dept. Hort., Bangladesh Agril. Univ. Mymensingh.

Pathak, V. N, 1973, Disease of fruit crop. Oxford and IBH Publishing Co. New Delhi. pp. 21 -22.

Pathak, V. N. 1974. Diplodia stem-end rot of mango and its control. Indian farmers digest 3: 43-45.

Popene, W. 1964. Tropical and sub-tropical fruits. The McMillan Co. Ltd. New York. 474 p.

* Prakash, O. and Singh, U. N. 1980. Fungicidal control of red rust of mango. Indian J. Mycol, Pl. Path. 10 (2): 175-176.

* Rao, S. C. and Ramesh, C. R. 1987. Occurrence of Parasitic algae (*Cephaleuros virescens kunze*) on black pepper and cloves in Andamans. J. Andaman Sci. Assoc. 3 (2): 143-144.

Safeeulla, K. C. and Govindu, H. C. 1948. Some new hosts of *Cephaleuros*. J. Mysore Univ. Sci. 1: 47-49.

Salunkhe, D. K. and Desai. B. B. 1984. Postharvest Biotechnology of fruit (vol. 1) CRC press. Inc. Boca Paton Florida. 77-94 pp.

Santhanam, V. 1967. Breeding procedure for cotton. J. C. A. R., New Delhi, Tech. Bull., 10: 1-24.

Sardeshpande, J. S. 1988. A report of the plant protection sub-committee, Regional Fruit Research Station, Vengurla, Dist. Sindhudurg, pp. 6-7.

Sexana, R. K. and Sachan, S. N. 1978. A new host record for *Cephaleuros virescens kunze*. Geobios. Dehra Dun, India. 5 (6):240.

Siddique, A. B. and Scanlan, F. M. 1995. Nutritive values of fruits. Int. Fruit Production Manual. pp. 1-288.

Singh, R. S. 1982. Principles of Plant Pathology. (3rd Edn.) Oxford and IBH publishing Co. 66 Jonapath, New Delhi. 328 p.

Singh,. I. B. 1968. The mango, Botany, Cultivation and Utilization. Leonard Hill. London. pp. 282-283.

Suit, R. E. and Du Charme, E. P. 1946. The *Cephaleuros* disease of Citrus. J. Citrus in India. 27: 3.

Thakur, D. P. and Chenulu. V. V., 1966. Intl. symp. on plant Pathology, Dec. 27. 1966-Jan. 1. 1967. Indian Phytopathological Soci. New Delhi. pp. 35.

Tiwari-RKS and Singh, J. 1999. Scientific Horticulture. Regional Agricultural Research Station, Sarkanda Farm Bilaspur, India. pp. 14.

Tunstall, A. C. and Sarmah, K. C. 1947. Notes on stem disease of Tea. Memor. Tocklai Exp. Sta. 16: 5.

Vidhyasekaran, P. and Parambaramani, C. 1971. Carbon metabolism of infected plants. Indian Phytopath. 24: 500-504.

Vidyasekaran, P. and Parambaramani, C. 1970. Carbon metabolism of alga infected plants. Indian Phytopath. 24 (2): 269-374.

Vinak, A. and Mander, C. L.1994. *Cephaleuros* infection on leaves of litchi plant. Research Bulletin of Panjab .University, Chandigarh, India 44 (1-4) 165: 172.

Vir, D. 1967. Plant disease problems. Indian Phytopathological Soc. New Delhi. pp. 316-320.

Yadava, A. S. 1955. Some new hosts of *Cephaleuros* from Bihar. Curr. Sci. 24 (4): 124.

Yadava, A. S. 1953. Some new host of *Cephaleuros* from Bihar. Curr. Sci. 22: (2) 280.

Vinak, A. and Mander, C. L.1994. *Cephaleuros* infection on leaves of litchi plant. Research Bulletin of Panjab .University, Chandigarh, India 44 (1-4) 165: 172.

Vir, D. 1967. Plant disease problems. Indian Phytopathological Soc. New Delhi. pp. 316-320.

Yadava, A. S. 1955. Some new hosts of *Cephaleuros* from Bihar. Curr. Sci. 24 (4): 124.

Yadava, A. S. 1953. Some new host of *Cephaleuros* from Bihar. Curr. Sci. 22: (2) 280.