



Plant Protection

ORIGINAL ARTICLE

Diseases and insect pests status of commercially grown jujube in Bangladesh

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ABSTRACT

Jujube is one of the important high value fruit crops of Bangladesh. Commercial cultivation of Jujube increased all over Bangladesh because of its high yield potential, nutritive value and high market price. But with the expansion of its cultivation, prevalence of diseases and insect pests increase significantly. For identification and management of those diseases and insect pests and to identify other Jujube related problems a comprehensive survey needs to be done for cultivating Jujube in an economic manner. A survey has been carried out to know the prevalence of diseases and insect pests of Jujube and their management status in five major Jujube growing areas of Bangladesh during three consecutive years. A total of seven problems were identified during survey of them diseases and insect pests' attack was found as one of the major constraints for commercial cultivation of Jujube. The powdery mildew, fruit drop, fruit spot and rot, sooty mold, leaf rust and leaf spot were identified as common diseases of Jujube in the surveyed areas. Regarding pest infestation, a total of eleven insect pests were identified during survey and white spider mite reported first time on Jujube in Bangladesh. In terms of management aspects, Thiovit, followed by Bavistin, Contaf, Tilt, Companion and Score were observed as frequently used fungicides to control diseases in commercial orchards. The growers prefer alternate spray of more than one fungicide than single application. The effectiveness of fungicides was satisfactory with little variation as opined by the growers. In addition, Ripcord, Symbush, Emitaf, Cythrin, Furadan and Regent were commonly applied insecticides against insect pests. The use of chemicals by the growers was not satisfactory as per recommendation. The approximate loss due to powdery mildew disease was 25-30%, it might be as high as 80-100% while control measures did not take in time. On the other hand, post-harvest disease loss was around 20-25%. For preparing good diseases and pests' identification and management programs of Jujube in Bangladesh, above mention information will play significant role.

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INTRODUCTION

Recently, Jujube (*Ziziphus mauritiana* Lam.) becomes one of the important high value fruit crops in Bangladesh. It was an old indigenous fruit cultivated only in homestead throughout the country. Commercial cultivation of Jujube has been increased dramatically in different parts of Bangladesh due to its high yield potential, nutritive value and high market price. The development of some high yielding varieties like BAU Kul,

BARI Kul-1 and Apple Kul also play significant role to flourish commercial cultivation of Jujube countrywide. Recent reports revealed that commercial production of Jujube is going down due to various unknown factors among them diseases and insect pests are suspected to be the important one. In India and China, various researches have been carried out on different aspects of Jujube diseases and related issues like, disease identification,

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epidemiology and management (Menziez et al. 1992; Reuveni et al. 1995; Pareek and Nath 1996; Cheah and Page 1997; O'Brien et al. 1988; Natura Singh and Geeta-Sumbali 2000; Lei et al. 2000; Sharma et al. 2001; Thind et al. 2004; Jamadar et al. 2009; Jat and Goyal 2009; Yuan et al. 2009). But to date knowledge, no comprehensive research work has been done on the diseases of Jujube in Bangladesh. Before initiation of detailed research works, it is paramount important to know the present condition of diseases, disease related issues and insect pest status regarding Jujube cultivation. To fulfill these requirements, a survey was conducted to identify the causes of yield reduction and quality deterioration of Jujube and to find out the present status of different diseases and insect pests on commercially cultivated Jujube in Bangladesh.

MATERIALS AND METHODS

More or less Jujube can grow throughout the country but presently, commercial Jujube cultivation mostly distributes south and north western parts of Bangladesh. For this reason, a survey has been conducted in five districts of Bangladesh namely Pabna, Rajshahi, Rangpur, Gazipur and Mymensingh (Figure 1). Data were collected using previously made questionnaire according to the objectives of the study during three consecutive years of 2007-08, 2008-09 and 2009-10 and sample size was 150.



Figure 1. Major Jujube growing areas (star indicates) from where Jujube disease samples and other related information were collected during survey

In case of leaf, branch, stem and inflorescence diseases, researcher approaches for data collection on diseases of Jujube and post-harvest loss estimation were random observation of 10 orchards of each location. Twenty (20) plants were selected per orchard and all five locations were considered. In case of post-harvest diseases of Jujube, data were collected from five orchards and five local markets of each year and each location. Twenty plants per orchard were selected and period of data collection was 15 December to first week of February of each year. Data on yield loss were measured by visual observation of individual orchards and markets and consultation with Jujube

growers. Simultaneously, yield loss data were collected from different Jujube growers using pre prepared questionnaire. Then researcher observation and farmers' information on yield loss of Jujube were combined for making good information. Disease incidence and severity were calculated by following standard scale and formula described by Bakr et al. (2010).

Jujube diseases were categories as major, moderate and minor based on high prevalence, respondent opinion and nature of damage like Major disease (High prevalence, $\geq 50\%$ respondents opinion and high nature of damage), Moderate (Medium prevalence, 30%-49% respondents opinion and moderate nature of damage), Minor (Less prevalence, $< 30\%$ respondent opinion and minimum nature of damage).

Insect pests' related information and data were collected with the help of entomologist and available literatures by Prodhan et al. (2011). In 2009-10, some white spider mite suspected samples were collected from different orchards of Gazipur and carefully examined under stereo and compound microscope at Microbiology laboratory, Bangabandhu Sheikh Muzibur Rahman Agricultural University and Plant Pathology Laboratory of Bangladesh Agricultural Research Institute. Collected information and data were then systematically compiled, arranged and analyzed with the help of MS Excel program in order to prepare an easily understandable report for end user.

RESULTS AND DISCUSSION

Prevalence of Jujube Disease and its Management Status

Disease status

Data presented in Figure 2, Plate 1-2 showed the per cent respondents' opinion about different suspected diseases that ranged from 8 to 93%. Around 93% Jujube growers could recognize powdery mildew was the most destructive disease followed by fruit drop (84%), fruit spot and rot (81%) and sooty mold (64%). Other observed diseases were leaf spot and blight (63%), leaf rust (45%), deform fruit (43%), leaf distortion (13%), stem bleeding and rotting (8%) and black leaf spot (14%). Disease symptoms were then categorized into three major groups 'viz. symptoms on leaf and twig, on trunk and inflorescence and symptoms on fruit. Description of disease symptoms of Jujube and its causal agents were identified according to Hoque et al. (2012).

Status of disease management

The growers were accustomed to use more than one chemical on orchard in the same cropping year. Thiovit was found as the most (72%) frequently used fungicide by the Jujube growers followed by Bavistin (56%) and Contaf (47.3%) (Figure 3). Some of the respondents opined that Thiovit acted both as fungicides as well as sulfur fertilizer. Tilt (31.3%), Companion (16%) and Score (14.7%) were also applied by Jujube growers to control different diseases. In addition, most of the respondents (84.7%) applied fungicides as an alternate spray rather than single spray to control diseases effectively.

The time of fungicidal spray is one of the most important considerations for plant disease control. Pruning is very effective to avoid pests and diseases for commercial Jujube cultivation. Most of the respondents were observed to prune Jujube trees at last week of March to second week of April of every year. However, only 33% commercial Jujube growers were following to apply fungicides just after pruning which is prerequisite to get healthy and productive plants. While 28% growers were started spray at two month after pruning, whereas only 7% started spray at five months after pruning (Figure 4). Field observations showed that most of the farmers using more than one chemical

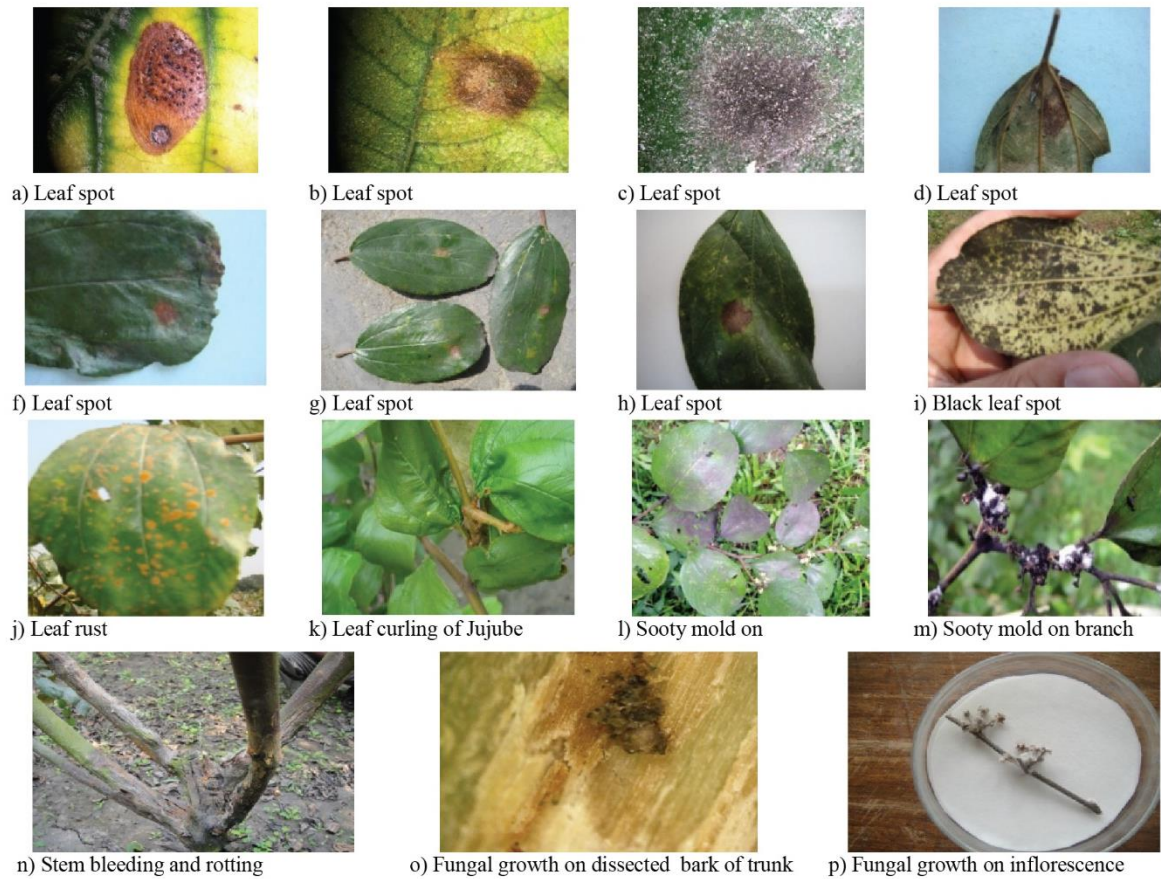


Plate 1. Symptoms on leaf, trunk and inflorescence of Jujube during survey



Plate 2. Symptoms on diseased fruits of Jujube during survey

at a time. Single or mixed fungicides were sprayed more than seven times on Jujube orchard by about 25% Jujube growers whereas fungicide spray six times by 24% and seven times by 20% growers in a cropping season. Only 5% growers were spray fungicides on Jujube orchard three times in a cropping year (Figure 5). Among the surveyed growers, 35% were found to spray fungicides at an interval of 10-15 days followed by 7-9 days (29%) and 26-30 days (19%) (Figure 6).

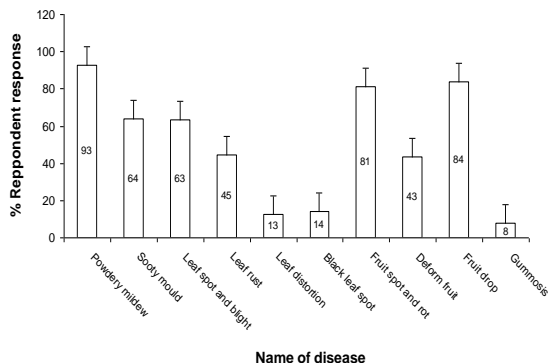


Figure 2. Respondents opinion about suspected Jujube diseases

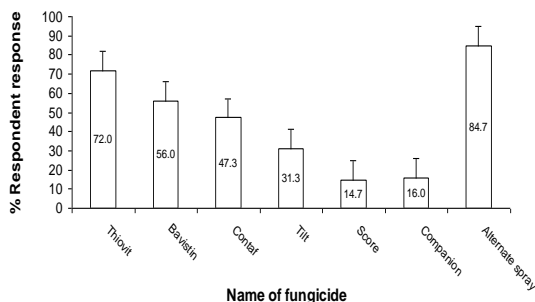


Figure 3. Respondents opinion about frequently used fungicides on Jujube orchards

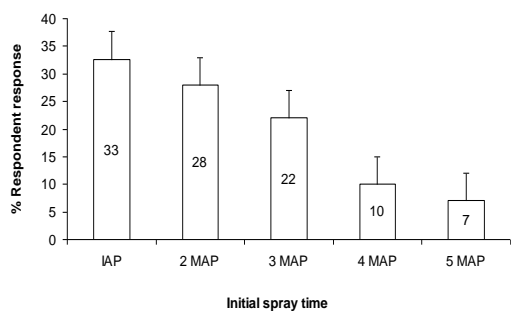


Figure 4. Respondents opinion about initial spray time of fungicides on Jujube orchards

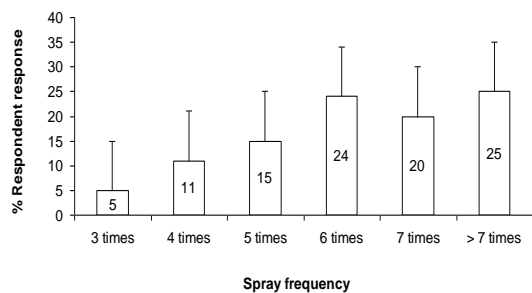


Figure 5. Respondents opinion about frequency of fungicides application on Jujube orchards

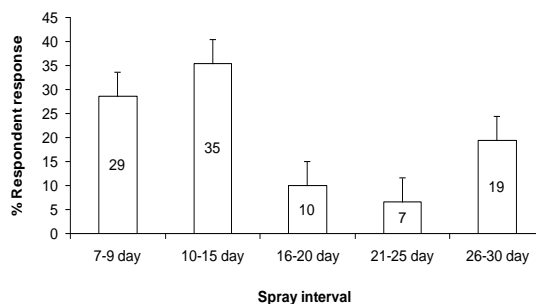


Figure 6. Respondents opinion about interval of fungicides application on Jujube orchards

The effectiveness of available fungicides to control different Jujube diseases was evaluated by the opinion of commercial growers of five selected areas (Figure 7). Twelve per cent (12%) growers remarked the available fungicides were very good, 47% said good, 34% respondents assessed as satisfactory, and 7% mentioned not effective. Overall, the effectiveness of fungicides was satisfactory with little variations. The necessity of maintaining fungicidal quality by random quality checking by competent authority was focused by the respondents (55%) (Figure 8).

To sum up, farmers were found more or less conscious about the common Jujube diseases. However, the farmers' attitude and knowledge in using fungicides with proper dose, frequency and interval were inadequate. These lacking might be avoided by proper training on modern Jujube cultivation highlighting the residual effect of fungicides in fruits which ultimately might reduce cost of production and enhance quality of fruits when marketing.

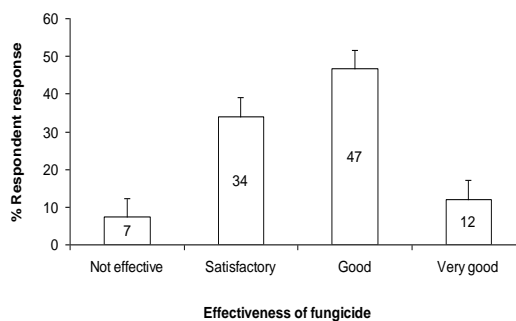


Figure 7. Respondents opinion about effectiveness of available fungicides against Jujube diseases

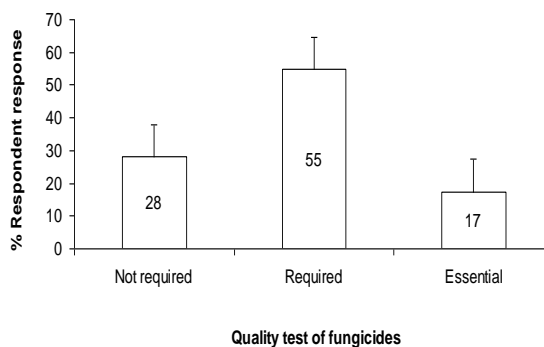


Figure 8. Respondents opinion about quality test of available fungicides commercially found at different markets of Bangladesh

Insect Pest Status of Jujube and its Management

Insect pest status

During the entire period of survey, eleven insects and mites were observed and identified (Figure 9 and Plate 3 and 4). Respondents could not recognize all the insect pests observed in orchards. The nut weevil was found as the most severe pest of improved Jujube. Out of 150 respondents, 69% opined that its frequency and nature of damage was the highest. The second highest frequently occurring insect was mealy bug (56%), followed by scale insect (53%), leaf feeding caterpillar (31%), leaf minor (30%), fruit borer (29%) and fruit fly (20%). Tube spittle bug and red mite was another important insect-pest of Jujube, but recognized by only 9% and 7% respondents, respectively (Figure 8). Insect pests of Jujube were identified following the literatures stated by Prodhhan et al. (2011).

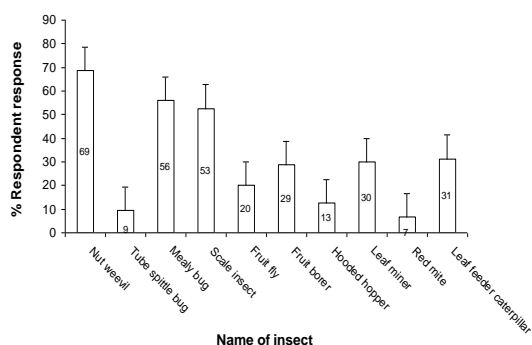


Figure 9. Respondents opinion about insect pests observed on Jujube

White spider mite was the newly reported mite pests of Jujube in Bangladesh. It was very dangerous pest on young nut, especially in BAU Kul and BARI Kul-1. Farmers were not aware about this pest. Field observation revealed that insect and mite pests attack was another important cause for low yield of Jujube in Bangladesh. Thus, combined management of diseases and insect pests of Jujube should be needed urgently to save the crop. Details description of white spider mite is stated below.

New record of white spider mite on Jujube in Bangladesh

White spider mite is one the most important pests of Jujube in Bangladesh. It was reported for the first time on improved Jujube specially BAU Kul and BARI Kul-1. White spider mite and powdery mildew disease were observed on young nut simultaneously. The symptoms of white spider mite are highly similar with powdery mildew disease. Whitish appearances on young nuts are the characteristic symptoms of this mite pest. Eggs and tiny mites were found on symptomatic nuts covered by whitish net like structures. Gradually, fruits become reddish, shriveled, dried and finally turns black. Mite sucks nutrient from young fruits. They caused immature fruit drop or produce deformed fruits (Plate 4 a-c and Plate 3). The white spider mite is not seen with naked eyes. However, numerous eggs were seen under compound microscope. They were soft bodied and transparent (Plate 4 a-c) and were mostly concentrated on young fruit at the grove near pedicel.

Insect pest management status

Insect pests are other important constraints of commercial Jujube cultivation. For pests' control, Jujube growers frequently used many insecticides and nematocides (Figure 10). Symbush and Ripcord were the most applied insecticides and 68% growers applied those for controlling different insects. The Emitaf was recorded as the second highest used insecticides (59%) followed by Cythrin (57%) and Sevin (20%). Most frequently used nematocides were Marshal (34%) and Furadan (33%) (Figure 10).

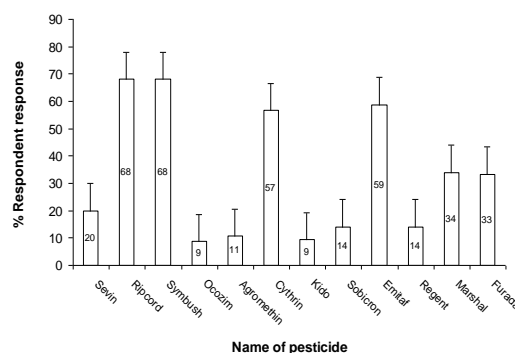


Figure 10. Respondents opinion about frequently used pesticides on Jujube orchards

Indiscriminate use of pesticides was observed during the survey. Maximum growers (40%) used pesticides more than seven times, 27% growers applied seven times and 20% growers applied at six times in a cropping season (Figure 11). In terms of spray interval, 40% growers were maintained 5-9 day and 28% growers maintained 10-15 day interval (Figure 12). Maximum respondents (45%) were found to start insecticides spray at 90 days after pruning (DAP) (Figure 13).

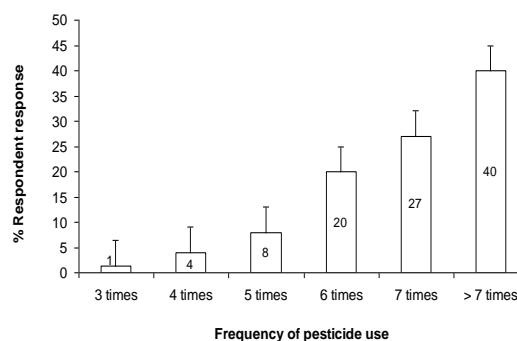


Figure 11. Respondents opinion about frequency of pesticides application of Jujube

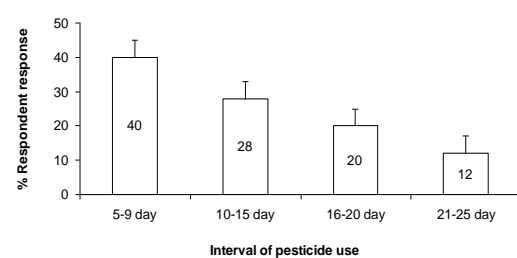


Figure 12. Respondents opinion about interval of pesticides application of Jujube orchards

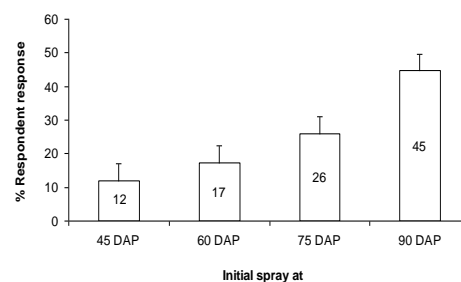


Figure 13. Respondents opinion about initial spray of pesticides on Jujube orchards

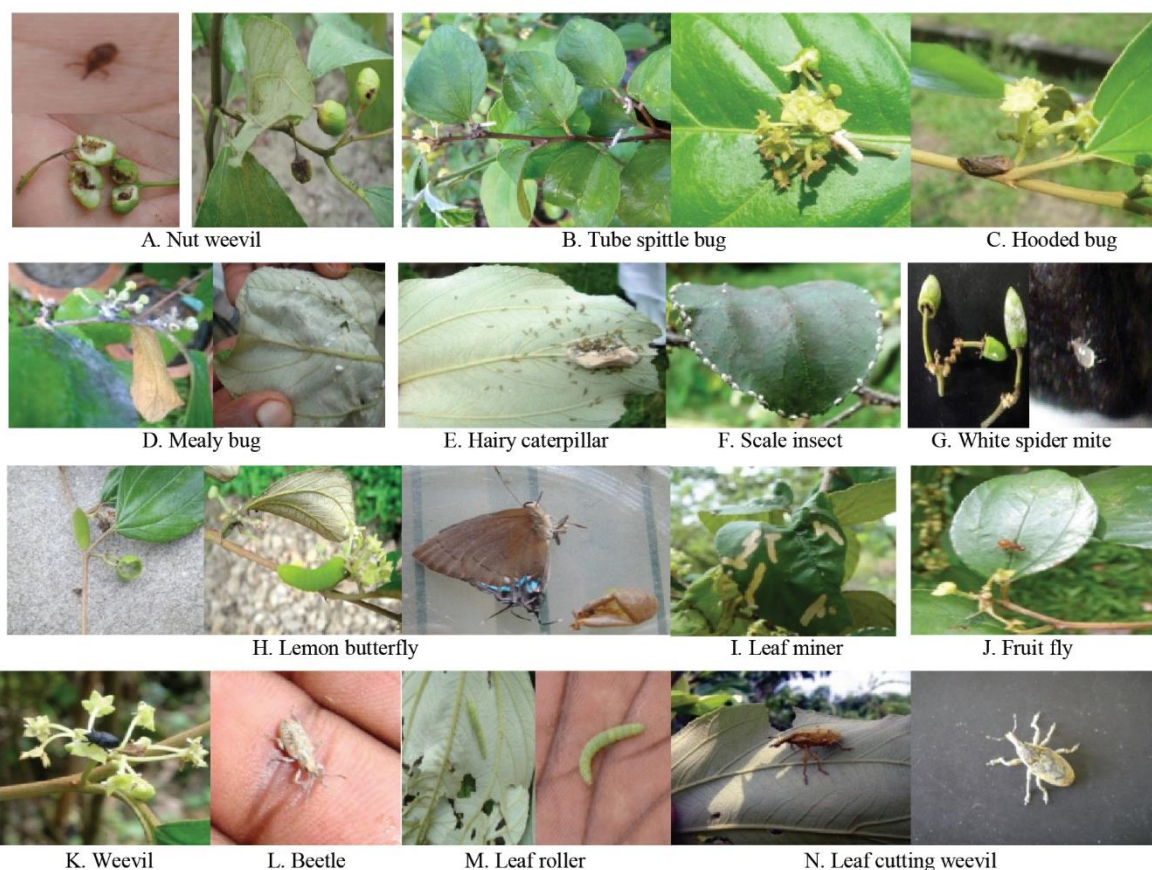


Plate 3. Major insect pests of Jujube identified during the survey



Plate 4a. White spider mite on young fruit

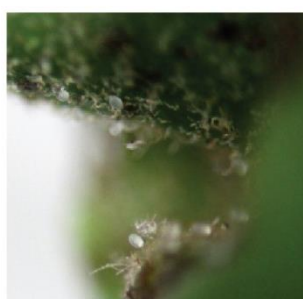


Plate 4b. White spider mite and eggs on young fruit



Plate 4c. Adult white spider mite

Plate 4. White spider mite on young Jujube fruits

The effectiveness of available insecticides to control different insect pests of Jujube was assessed by the opinion of commercial growers of five selected areas (Figure 14). Thirty six percent (36%) growers said the available insecticides were satisfactory, 32% said good and 21% said not effective at all. Overall, the effectiveness of insecticides was satisfactory with little variations. The necessities of maintaining insecticidal quality, random quality checking by competent authority were focused by the respondents of 49% (Figure 15). From these results, it was summarized that Jujube growers were concerned about the insect damaging issues and use of insecticides but application of insecticides was not rational. Some growers apply more than five insecticides and spray frequency was 15-20 in a cropping season but it was not justified in respect of cost of production and environmental issue. Thus, proper monitoring and training should be needed for accurate identification of pest and rational

use of pesticides as well. Searching of other management options instead of pesticides is indispensable.

Status of Plant Hormone Use

Hormone applications

Seventy percent (70%) Jujube growers were found to apply various hormones namely, Cropscare, Litocin, Boxsol, Voxcin, Bio-green and Flora to increase fruit retention and to upgrade quality of Jujube fruits. Among the hormones, Litocin was the most frequently (41%) used one (Figure 16). Effectiveness of hormone application was assessed by the growers where 37% growers mentioned hormone was good, 29% opined satisfactory, 9% opined very good and 25% said it was not effective (Figure 17).

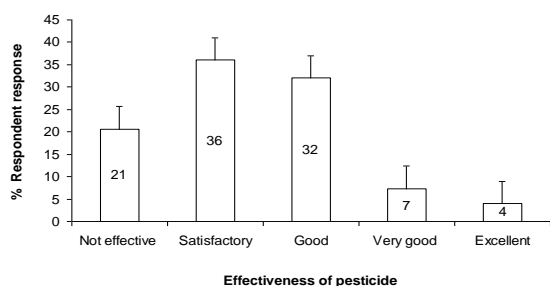


Figure 14. Respondents opinion about effectiveness of pesticides against insect pests of Jujube

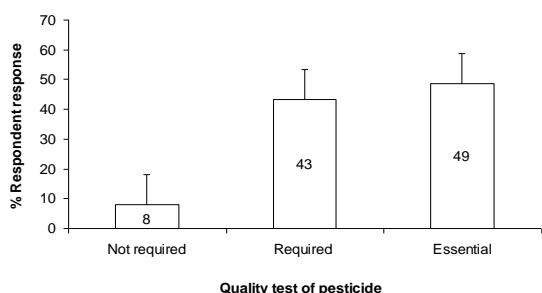


Figure 15. Respondents opinion about quality test of available pesticides commercially found at different markets of Bangladesh

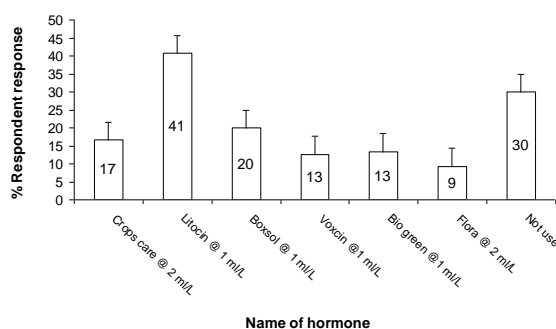


Figure 16. Respondents opinion about hormone use on commercial Jujube orchards



Figure 17. Respondents opinion about effectiveness of hormone on commercial Jujube cultivation

Application methods and time

The frequency of hormone application varied one to two times. Fifty nine (59%) percent Jujube growers applied hormone once only during fruit set and 41% used hormone two times, just before flowering and during fruit set (Table 1).

The Jujube growers were concerned about hormone application and satisfied with influence of hormones on fruit yield and quality. However, selection of appropriate hormone, time of application and use in recommended dose should be taken into consideration to get higher yield with good quality.

Pruning and intercultural operations

Pruning is an important cultural practice of Jujube cultivation. Yield and quality of Jujube is highly influenced by proper pruning. It reduces the intensity of pests and diseases pressure. Moreover, new branches emerged after pruning is more productive than the older ones. Jujube growers of Bangladesh presently practiced one or two times pruning. Most of the growers (70%) pruned there plants one time in a year, during March-April and type of pruning was hard. Conversely, only 30% growers' were followed two times pruning, both hard and light pruning at March-April and July-August of every year, respectively. In case of fungicides apply after pruning, 58% respondents was not applied any fungicides after pruning. However, 42% growers properly followed the fungicides application after pruning (Table 2).

Technical Support Provided by Different Organizations

Field observation reveal that most of the growers were not educated enough. They usually collected information on Jujube cultivation especially on plant protection problems from different sources. Data represented that 53% respondents received technical information from pesticide dealers, 41% collected information from Department of Extension (DAE), 27% from fellow growers, 16% from research organizations and 11% from NGOs (Figure 18).

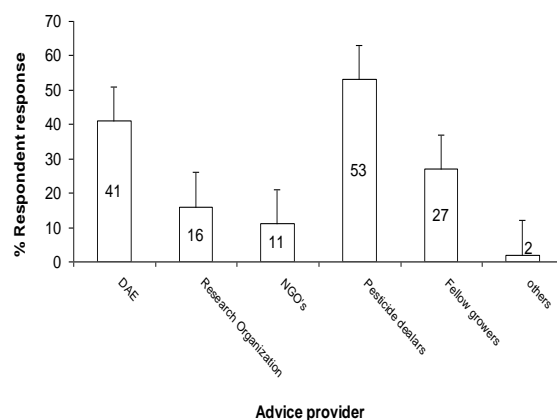


Figure 18. Advice received by commercial Jujube growers from different source

Major Problems of Commercial Jujube Cultivation

During survey works some important problems were come out from direct conversation with commercial Jujube growers. Ninety percent (90%) respondents opined that low price of Jujube at farm level at harvest was the most important drawback (Table 6). According to 85% growers' said that disease and insect pests were the second important problem for Jujube cultivation. The major part of cost of production belongs to cost of fungicides and pesticides. Other problems detected by growers according to importance were lack of technical support (57%), lack of government funding or credit (42%), availability of inputs at proper time (38%), lack of adequate knowledge about cultivation procedures (31%) and adverse weather conditions (16%).

Table 1. Frequency and time of hormone application by Jujube growers

Frequency	Time of application	% Respondent response
One time	During fruit set	59
Two times	Just before flowering and during fruit set	41

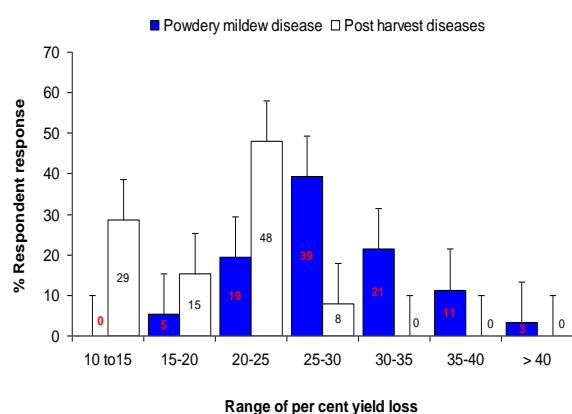
Table 2. Pruning practices followed by Jujube growers

Pruning frequency	Time of pruning	Types	% Respondent response	Fungicides apply after pruning	% Respondent response
Two times /year	March-April	Hard	30	Yes	42
	July -August	Light			
One time / year	March-April	Hard	70	No	58

Disease Incidence, Severity and Yield Loss of Jujube Diseases

Powdery mildew disease of Jujube

Disease incidence of powdery mildew of Jujube ranges from 45-90 %. The highest (90%) incidence was recorded in Pabna and Mymensingh district in the year 2009 compared with rest two years (2008 and 2010). In case of disease severity, it ranges from 2.1-3.2 (0-5 scale). The highest disease severity (3.2) was recorded from Rajshahi in the year 2009. The maximum yield loss (40-80%) due to powdery mildew disease was also recorded at Rajshahi whereas minimum (30-60%) at Rangpur and Mymensingh during 2009. Altogether, disease incidence, disease severity and yield loss were higher at all location during 2009 than rest two years. Effect of location on powdery mildew disease was not distinct. It was varied mostly due to cropping years (Table 3a). Average disease incidence, disease severity and yield loss of powdery mildew disease were 68 %, 2.6 and 25-41%, respectively, irrespective of locations and cropping years (Table 4 and 5). On the other hand, about 40% Jujube growers opined that yield loss due to powdery mildew disease was 25-30% (Figure 19). Researcher findings and growers opinion revealed that powdery mildew was a very devastating disease of Jujube and it may cause 25-40 % yield loss of Jujube. Prevailing weather condition might be played decisive role on the development of powdery mildew disease. Farmers' awareness and skills regarding the time of disease identification and application of fungicides might be another important factors for determining the development of powdery mildew disease.

**Figure 19.** Growers opinion about per cent yield loss of Jujube due to powdery mildew and post-harvest diseases

Post-harvest diseases of Jujube

Post-harvest disease incidence of Jujube ranged from 20-30 %. The highest (30%) incidence was recorded in Rajshahi and Rangpur district in the year 2009. In case of disease severity, it ranges from 2.0 – 3.5. The highest disease severity (3.5) and maximum yield loss (25-35%) due to post-harvest diseases were also recorded from Rajshahi in the year 2009. But the lowest disease severity (2.0) and post-harvest loss (13-20%) were recorded at Pabna and Mymensingh in the year 2010, respectively (Table 3b). Average disease incidence, disease and severity of post-harvest diseases were 24% and 2.7, respectively, irrespective of locations and cropping years (Table 5). Post-harvest diseases were the highest in the year 2009 than rest two years. At all locations, generally post-harvest diseases loss was higher. But it was highest at Rajshahi and Rangpur irrespective of cropping years. Effect of cropping years and locations on post-harvest diseases of Jujube was significant (Table 3b). Irrespective of locations and cropping years, estimated average yield loss due to post-harvest diseases by researcher observation was 18-26% but according to 48% respondents' response yield loss was 20-25%. Both researcher and respondents observation revealed that it was almost 20-25% (Table 4 and Figure 19). Soil and climatic conditions of different locations were not similar that might be the important cause of variability of different post-harvest diseases of Jujube. Farmers' intervention might be another important cause for the variability of the development of post-harvest diseases of Jujube.

Sooty mold disease of Jujube

Sooty mold is another important disease of Jujube. Disease incidence, disease severity and yield loss of sooty mold disease of Jujube ranged from 10-25 %, 2.5-3.5 and 5-10 % to 20-25 %, respectively. The highest disease incidence (25%), disease severity (3.5) and yield loss (20-25%) were recorded in Gazipur than other locations. Cropping year 2009, was more favourable than other two years for the development of sooty mold disease of Jujube. Pabna was the lowest sooty mold prone area followed by Rajshahi, irrespective of all cropping years. Sooty mold disease pressure was moderate at Rangpur and Mymensingh during all cropping years (Table 3c). Average disease incidence, disease severity and yield loss of sooty mold disease were 17%, 3.1 and 11-14%, respectively, irrespective of locations and cropping years (Table 4 and 5). Weather condition, previous inoculum pressure, presence of mealy bug infestation, pesticides application status and farmers intervention might be the major determining factors for sooty mold development on Jujube.

Leaf rust disease of Jujube

Leaf rust is another important leaf disease of Jujube that reduces photo synthetic capability of plants, causing nutrient deficiency

which hinder plant growth ultimately yield of Jujube reduced notably. Effect of locations was significant whereas, effect of cropping year was insignificant on leaf rust disease of Jujube. The highest disease incidence, disease severity and yield loss ranged from 50-80%, 2.0-3.4, and 5-10% to 8-12%, respectively (Table 3d). However, average disease incidence, disease severity and yield loss of leaf rust disease were 84%, 2.6 and 6-10%, respectively, irrespective of locations and cropping years (Table 4 and 5). Mymensingh was more disease prone than others locations whereas, disease proneness was the lowest at Pabna (Table 4d). Variability of rust disease according to locations might be due to the soils and climatic conditions of the selected areas, degree of pesticides application and growers' knowledge regarding Jujube cultivation played the major role.

Leaf spot diseases of Jujube

Various leaf spot diseases of Jujube were seen during survey periods (Plate1). Survey results revealed that locations and cropping years had some effect on leaf spot diseases of Jujube. Disease incidence, disease severity, and yield loss was ranged from 70-90%, 1.0-2.0 and 3-5% to 3-8%, respectively (Table 3e). However, irrespective of locations and cropping years, average disease incidence, disease severity and yield loss of leaf spot disease were 84 %, 1.5 and 4-7%, respectively, (Table 4 and 5).

Table 3. Disease incidence, disease severity and yield loss of different Jujube diseases of five selected growing areas of Bangladesh during 2008-2010

a) Powdery mildew disease of Jujube

Locations	2007-08			2008-09			2009-10		
	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss
Pabna	65	2.4	20-30	90	2.9	35-70	60	2.2	20-25
Rajshahi	60	2.5	25-40	85	3.2	40-80	55	2.3	15-25
Rangpur	65	2.3	20-30	80	3.0	30-60	60	2.7	30-40
Gazipur	60	2.1	15-20	85	3.1	35-60	55	2.4	15-20
Mymensingh	65	2.3	20-30	80	3.0	30-60	50	2.4	20-30

b) Post harvest disease of Jujube (spot, rot, crack and deformation)

Locations	2007-08			2008-09			2009-10		
	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss
Pabna	20	2.1	12-18	24	3.3	18-30	23	2.0	14-22
Rajshahi	23	2.5	15-24	30	3.5	25-35	25	2.6	20-30
Rangpur	24	2.6	18-25	30	3.3	25-32	28	2.5	25-30
Gazipur	22	2.5	15-22	22	3.1	15-25	22	2.4	20-28
Mymensingh	25	3.0	20-25	25	3.2	20-28	20	2.3	13-20

c) Sooty mold disease of Jujube

Locations	2007-08			2008-09			2009-10		
	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss
Pabna	10	2.5	5-10	10	2.8	8-12	15	2.5	10-12
Rajshahi	15	3.2	8-12	15	3.0	10-12	15	3.0	10-12
Rangpur	15	3.4	10-12	20	3.3	10-15	20	3.2	10-15
Gazipur	20	3.5	15-20	25	3.5	20-25	25	3.3	20-25
Mymensingh	20	3.0	10-12	20	3.1	10-12	15	3.0	10-12

d) Leaf rust disease of Jujube

Locations	2007-08			2008-09			2009-10		
	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss
Pabna	50	2.2	5-10	55	2.0	5-10	55	2.0	5-8
Rajshahi	55	2.5	5-10	65	2.2	5-10	50	2.0	5-8
Rangpur	60	2.8	5-10	65	2.5	5-10	65	2.2	5-10
Gazipur	60	3.0	5-10	70	3.1	8-10	60	3.0	8-10
Mymensingh	75	3.4	8-12	80	3.2	8-12	75	3.2	8-10

e) Leaf spot diseases of Jujube

Locations	2007-08			2008-09			2009-10		
	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss
Pabna	70	1.0	3-5	80	1.2	5-8	75	1.0	3-5
Rajshahi	80	1.2	3-5	85	1.4	5-8	80	1.2	3-5
Rangpur	90	1.5	3-5	90	1.6	5-8	85	1.4	3-5
Gazipur	90	1.8	3-8	85	2.0	5-10	85	1.7	3-8
Mymensingh	85	2.0	3-8	90	2.0	5-10	90	2.0	3-8

f) Black leaf spot disease of Jujube

Locations	2007-08			2008-09			2009-10		
	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss	Disease Incidence (%)	Disease severity (0-5)	% Yield loss
Pabna	10	2.0	1-3	5	2.2	3-5	10	2.0	2-3
Rajshahi	15	2.4	1-3	10	2.5	3-5	10	2.2	2-5
Rangpur	30	3.5	5-10	25	3.4	5-10	40	3.2	5-10
Gazipur	20	3.3	5-8	30	3.2	5-10	30	3.1	5-10
Mymensingh	20	3.2	5-8	25	3.1	5-8	20	3.0	5-8

Table 4. Estimated yield loss due to major diseases of Jujube collected from farmers' field and markets during 2008 -10

Diseases	Yield loss (%)			
	2007-08	2008-09	2009-10	Average
Powdery mildew	20-30	34-66	20-28	25-41
Post-harvest diseases	16-23	21-30	18-26	18-26
Leaf spot	3-6	5-9	3-6	4-7
Leaf rust	7-10	6-10	6-9	6-10
Sooty mold	10-13	12-15	12-15	11-14
Black leaf spot	3-6	4-8	4-7	4-7

Table 5. Disease incidence and disease severity of six important diseases of Jujube collected from farmers' field and markets during 2008 -10

Diseases	Disease incidence (DI)			Disease severity (DS) (0-5 scale)			Average	
	07-08	08-09	09-10	07-08	08-09	09-10	DI	DS
Powdery mildew	63	84	56	2.3	3.0	2.4	68	2.6
Post-harvest diseases	23	26	24	2.5	3.3	2.4	24	2.7
Leaf spot	83	86	83	1.5	1.6	1.5	84	1.5
Leaf rust	83	86	83	2.8	2.6	2.5	84	2.6
Sooty mold	16	18	18	3.1	3.1	3.0	17	3.1
Black leaf spot	22	19	19	2.9	2.9	2.7	20	2.8

Table 6. Major problems of commercial Jujube cultivation according to growers' opinion

Items	% Respondent	Rank
Low price of Jujube at farm level	90	1
Diseases and insect pests	85	2
Lack of technical support	57	3
Lack of Government funding or credit	42	4
Availability of inputs at proper time	38	5
Lack of adequate knowledge about cultivation procedures	31	6
Adverse weather conditions	16	7

Pabna was the less disease prone area whereas; the highest disease prone area was Mymensingh. Cropping year 2009, was more susceptible year than other two (Table 3e). Leaf spot diseases were not severe during surveyed years but little variation was observed. Variability of leaf spot diseases might be varietals resistance, fungicides application status, prevailing weather condition and soil nutrient status of Jujube orchard

Black leaf spot disease of Jujube

Black leaf spot disease suspected to be a new disease of Jujube in Bangladesh. It varied markedly with locations (Table 3f). Disease incidence, disease severity and yield loss ranged from 10-40%, 2.0-3.5 and 1-3% to 5-10%. The highest disease incidence (40%), disease severity (3.5) and yield loss (5-10%) was found at Rangpur followed by Gazipur. But the lowest disease incidence (10%), disease severity (2.0) and yield loss (1-3%) was recorded at Pabna and followed by Rajshahi. Effect of cropping years on black spot disease was not significant. However, average disease incidence, disease severity and yield loss of leaf spot disease were 20%, 2.8 and 4-7%, respectively, irrespective of locations and cropping years (Table 4 and 5).

Major problems of commercial Jujube cultivation

During survey works some important problems were come out from direct conversation with commercial Jujube growers. Ninety percent (90%) respondents opined that low price of Jujube at farm level at harvest was the most important drawback (Table 6). According to 85% growers' said that disease and insect pests were the second important problem for Jujube cultivation. The major part of cost of production belongs to cost of fungicides and pesticides. Other problems detected by growers according to importance were lack of technical support (57%), lack of government funding or credit (42%), availability of inputs at proper time (38%), lack of adequate knowledge about cultivation procedures (31%) and adverse weather conditions (16%).

Specific Problem Observed in Apple Kul at Farm Level

Last three years field observation also revealed that female flower initiation of Apple Kul was significantly lower as compared with male flower, although bearing of flowers was sufficient. Such type of problems was not prevalent on BAU Kul and BARI Kul-1. During the survey, Jujube growers opined that the yield of Apple Kul was considerably lower due to low number of fruit set. As a result growers consistently lose their interest about the cultivation of Apple Kul. This might be happened due to variation of weather variables (especially effect of temperature at flowering stage), variation of micronutrient level, and other physiological causes. External application of hormones and micronutrients might influence initiation of female flower to get higher yield of Jujube. Therefore, future research should be focused on these issues that would be able to enhance the overall production of Jujube.

CONCLUSION

Based on results it may be concluded that the powdery mildew, fruit drop, fruit spot and rot, sooty mold, leaf rust and leaf spot were identified as common diseases of Jujube. On the other hand, a total of eleven insect pests were observed of which white spider mite was reported first time on Jujube in Bangladesh. In case of fungicide use, Thiovit, Bavistin, Contaf, Tilt, Companion and Score were frequently used fungicides and growers prefer alternate spray of more than one fungicide rather than single application. Fungicidal effectiveness was satisfactory with some variation. In terms of insecticides, Ripcord, Symbush, Emitaf, Cythrin, Furadan and Regent were commonly used insecticides against insect pests and their effectiveness were not satisfactory as per recommendation. Yield loss due to powdery mildew

disease was approximate 25-30%, it might be as high as 80-100% while control measures did not take in time. In addition, post-harvest disease loss was around 20-25%. These generated information give a clear idea about commercial Jujube cultivation of Bangladesh which help to formulate a good pests management plan and making profitable and sustainable commercial Jujube cultivation in Bangladesh

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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