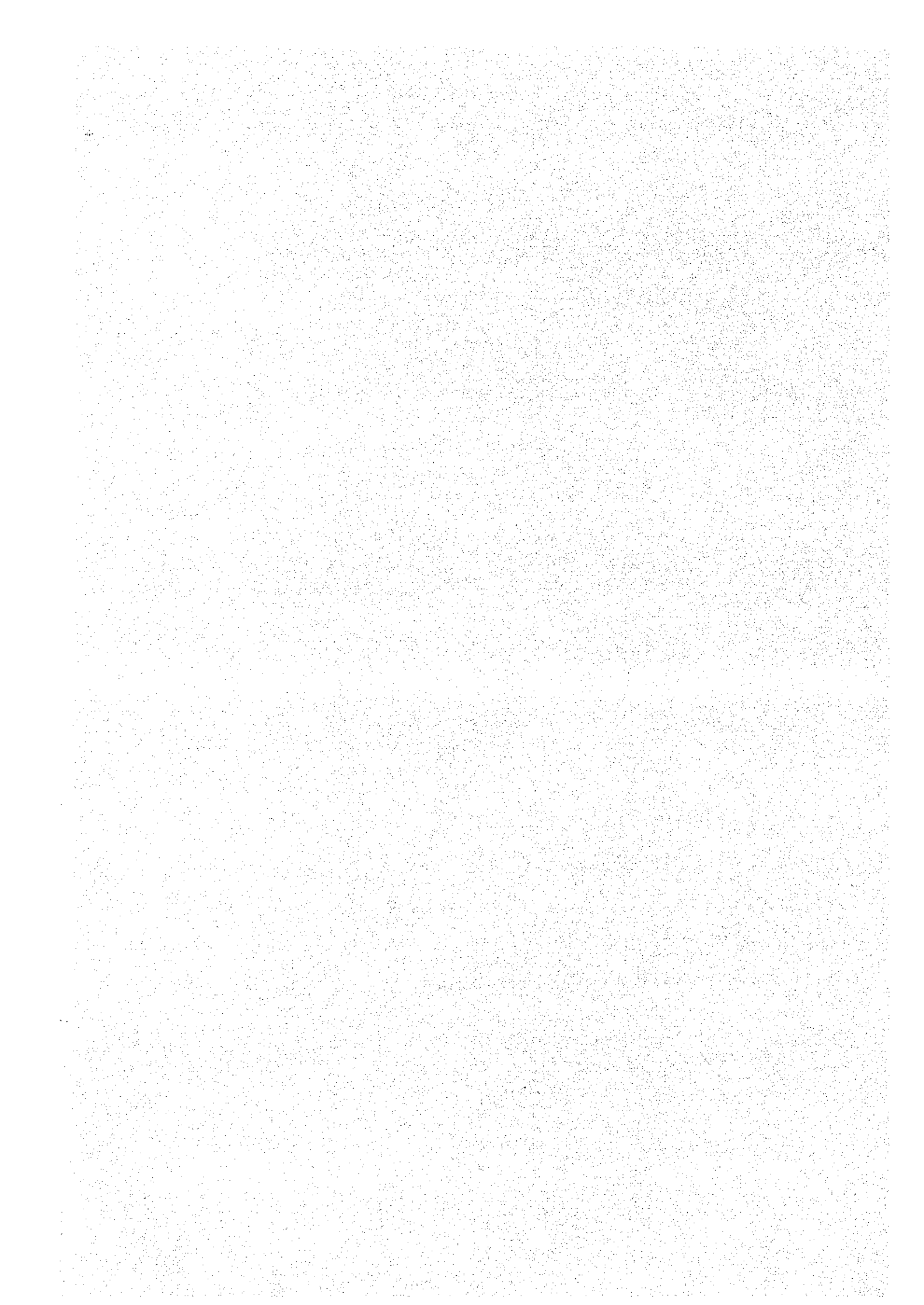


II. Report on the Citrus Research

Dr. Hiroshi Daito
Mr. A.M. Abdullah



FORWORD

I take this opportunity to congratulate Dr. H. Daito and Mr. A.M. Abdullah for their efforts to publish research activities of citrus section. Problems of citrus production is a challenge to us all. Many researchers opine that mandarin and sweet orange production may not be possible in Bangladesh because of accumulation of excessive heat unit. But it is a fact that mandarin has been growing in hilly areas in this country from time immemorial. This indicates that mandarin oranges can be grown here by lowering accumulation of heat units by planting shade trees in the orchard. Now, it is for the scientists to standardise this practice. Further, physiological disorders which may be due to micro and macro nutrient deficiency, micro-climatic effects and various diseases are major problems in citrus growing. Root stock selection for different groups of citrus plants for different agro-ecological zone of the country is an important aspect of citrus growing which is yet to be finalized.

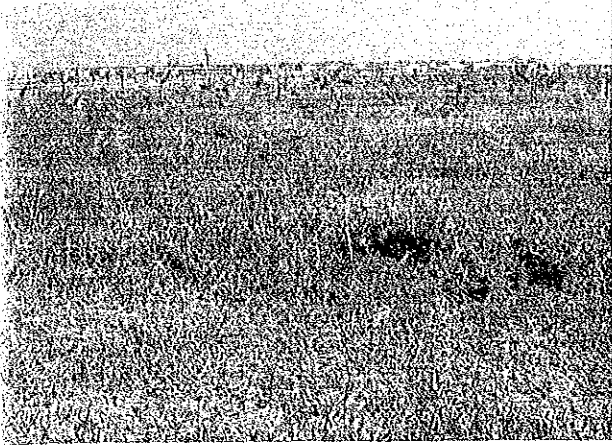
In the above background, this project was taken up in 1977 in collaboration with Japanese assistance. Mr. Y. Kodera joined in July, 1978 as first citrus expert. But there was inadequate fund even for land development. However, it was due to zeal and hard work of Mr. Y. Kodera, who left this project in 1981, it has been possible to introduce more than 100 cultivars of different citrus groups. Dr. H. Daito then joined to this project to provide leadership in this field. It is due to his untiring effort and leadership that it has been possible to initiate many research activities, a few of which has been completed. It was our misfortune that Dr. Daito left the project in the middle of 1982 for his wife's illness.

Due to inadequate funding, frequent change of experts and that citrus is a long standing crop, progress may not be outstanding in this field. But the results as well as experiences gained so far must be shared with all these who are interested in it through such a publication.

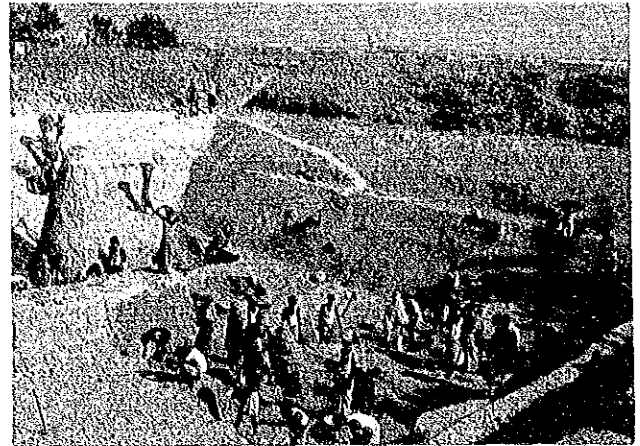
Once again, I would like to thank both Mr. Y. Kodera and Dr. H. Daito for their contribution in citrus research in Bangladesh. I would also like to extend thanks to A.M. Abdullah, Abdul Basher, Sanaullah Mollah, Nazim uddin, Zamiul Islam, Abdul Hoque, R. Sakaguchi and H. Nagai who have been involved in carrying out research in the field and compiling these at the desk.

(Dr. A.K.M. Amzad Hossain)

Head,
Citrus and Vegetable Seed Research Centre
BARI, Joydebpur, Dhaka.



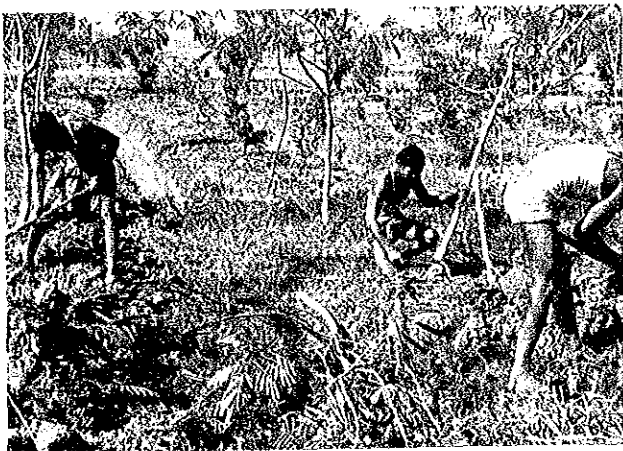
The field which citrus seedlings were not planted for lack of irrigation water.



Reservoir making



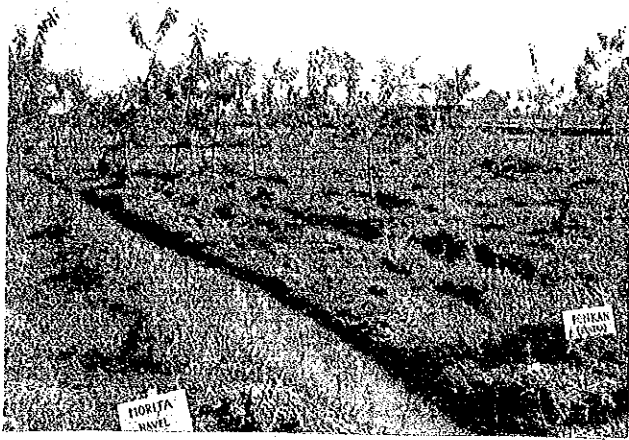
Citrus seedlings from Japan were raised on the Main Centre field(Right), thereafter, transplanted in the Sub Centre field(Left).



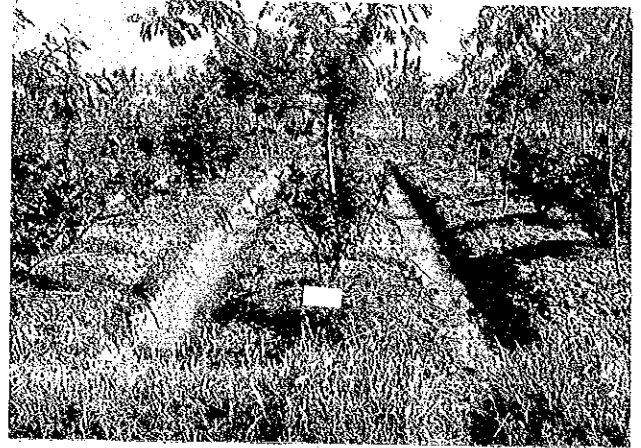
Ipil ipil trees were planted on the bed in order to protect citrus seedlings from strong wind and sunshine. After citrus seedlings raised, ipil ipil trees were thinned.



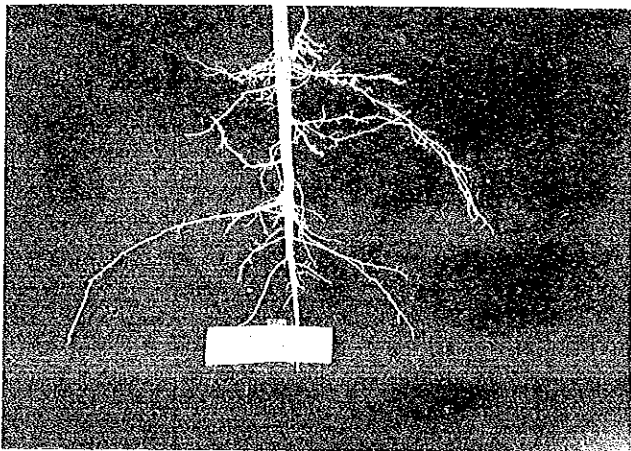
Ipil ipil's branches were buried in the citrus seedlings planting hole as source of organic matters.



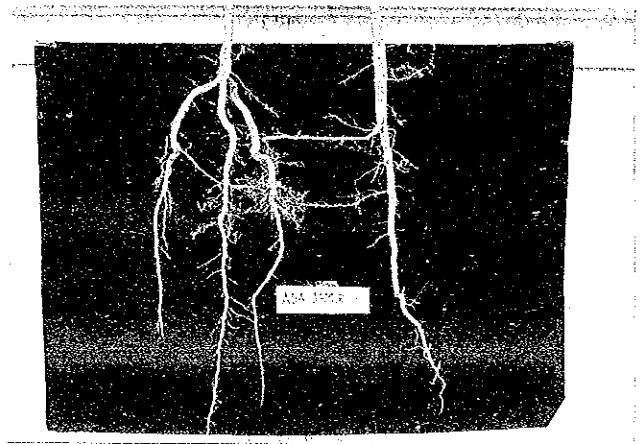
Some citurs seedlings could not grow due to excess soil moisture in rainy season.



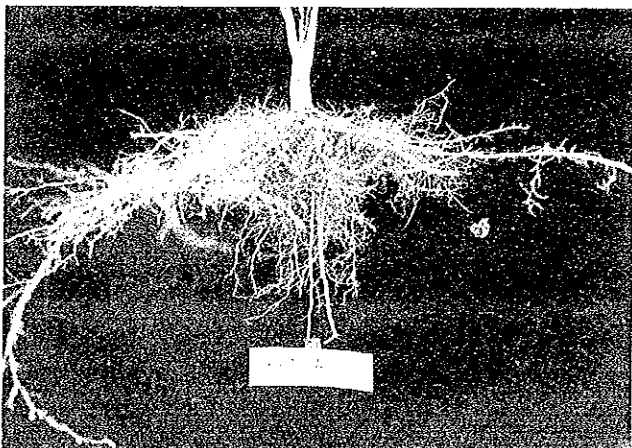
Citrus seedlings raised vigorously on the bed with deeply drainage ditch.



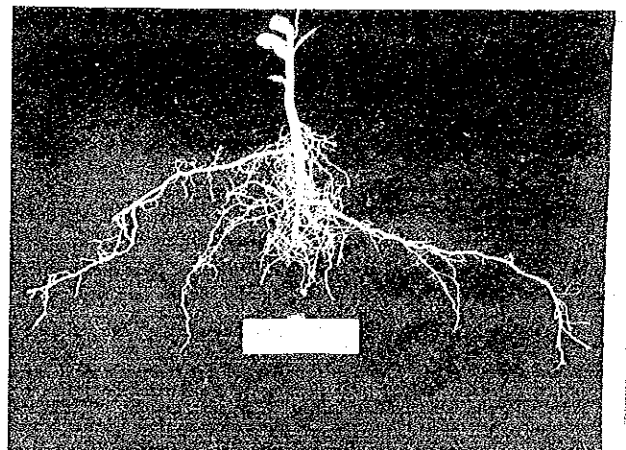
(Pummelo)



(Adahjamir)



(Adahjamir)



(Kagzi lebu)

The selection of suitable citrus rootstocks under the soil and climatic conditions of Bangladesh.

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Introduction

The Scheme Citrus and Vegetable Seed Research Centre; a co-operative project of the government of Bangladesh and Japan, was initiated in September, 1977. But the arrival of Japanese expert and development of physical facilities at the main centre took a long time. Mr. Y. Kodera, the first Japanese citrus expert joined this project in July, 1978. At his arrival, he found that no land development work was undertaken in the citrus block. Due to personal interest, he managed to get some fund from the JICA and bricks from BARI for the construction of internal roads and boundary fence.

Actual plantation was started in August, 1979 when few introduced mandarin, sweet orange, pummelo, lime and lemon varieties were planted in plot-5 at field No. 2. Again in January, 1980 he received saplings few more citrus varieties from Japan which were directly planted in plot No. 2. No attention was however given to improve the soil condition of citrus block until my joining. It is not clear, how it could happen with citrus block while the block earmarked for vegetable research were taken proper care of by the JICA. One land consolidation engineer Mr. Okamoto personally supervised the land development work of vegetable block who stayed at Bangladesh for about 6 months. When I arrived Bangladesh in June, 1981 I was surprised to see condition of the experimental plots. I thought over this issue and made a programme of my own to improve the field condition of citrus block with my sincere endcavour it was possible to develop the soil contition of plot No. 6 and 3. Gentle slope was created and a water reservoir was dug in these two plots. Further programme of making some irrigation and drainage over the entire block was in my mind which I could not materialize for want of time. I used to dream with the problems and how to develop the citrus industry of Bangladesh.

Although the climatic condition of Bangladesh (reported in many books and reports) is not confusion for growing mandarin and sweet oranges, but it is a good place for the cultivation of pummelo, lime and lemons. In my short stay at Bangladesh I tried to attack various problems to find solutions. I believe that variety adaptable under Bangladesh condition belonging to mandarin and sweet orange group can be found out if intensive search is continued in this direction.

Besides varieties and rootstock, the other important problem for cutrus industry in this country is diseases. But no expert on citrus disease was

despatched to this project. And as such no work could be taken up in this field. Same is the case with insect problem. The work that has been done in this two field is half-treated and depended on co-operation of other divisions of the BARI.

A list of researcher who helped me or were associated with the citrus research are appaled below:

CITRUS RESEARCH TEAM

- A. Main Centre - Hiroshi Daito
A. M. Abdullah
Shahidul Islam
M. Abu Taher
Ashraf Khan
Abdur Rouf
Shahana Begum
Anowara Begum
- B. Sub-Centre Ishurdi - Hidebumi Nagai
Jamiul Islam
Wahed Box
- C. Sub-Centre Jaintiapur - R. Sakaguchi
Abul Bashar
Nazim uddin
Abdul Hoque

The following description will give a brief account of the researchers that was done during my stay in Bangladesh.

Experiment No. 1.

(1) Survey of the present status of citrus production in all its aspects.

Researcher: A. M. Abdullah, and H. Daito, Jamiul Islam, and Abul Bashar.

Objective: Survey of the existing situation of citrus fruits production is a pre-requisite to prepare a good research programme. So in order to know the species/varieties/kinds of citrus fruits with their production areas; this study has been undertaken.

Materials and Methods:

This study was initiated in early, 1980. A proforma was developed for this purpose. The desired information therein was supposed to be collected through the visit of scientist working in the project. This method was however, not found to be practical as it requires large manpower for undertaking extensive tours. This also involves large expenditure with the arrival of Dr. H. Daito, the Japanese citrus expert the method was changed. It was stipulated that the proforma be filled in through agricultural extension workers. The proforma was, therefore, simplified keeping in view the treats of village extension agents. After modification, the proforma was sent to 100 Thana extension officer in 4 citrus growing districts of Bangladesh with a request to fill up the sheets and sent back to us for compilation of result. A specimen of the newly developed proforma is appended below:

Citrus and Vegetable Seed Research Centre
BARI, Joydebpur, Dhaka.

Proforma of the survey on citrus species/varieties
of Bangladesh

Name of Thana: _____ Dist: _____

A. Basic information:

1. Total area under citrus cultivation:

	<u>Area in acres</u>	<u>Yield/Year</u> (No.) Wr. in mds.
(a) Mandarin:		
(b) Malta :		
(c) Lemon & lime...		
(d) Pummelo :		
(e) Others :		

Total:

B. Specific information regarding any outstanding plant/common variety/wild variety (Please use separate sheet for each kind)

1. Name and address of the growers:

Result and Discussion:

Replies from 11 Thana extension officers namely Kulawara (Sylhet), Cunaihat (Sylhet), Kamalgong (Sylhet), Moulvibazar (Sylhet), Naikansari (Chittagong Hill Tracts), Naniarchar (Chittagong Hill Tracts), Panchari (Chittagong hill tracts), Matiranga (Chittagong hill tracts), Fakirhat (Chittagong), Cox's Bazar (Chittagong) and Patgacha (Khulna) have been received upto August, 1982. They have sent back 40 filled in query sheets wherein they have noted plants belonging to C. reticulata, C. grandis, C. aurantifolia, C. lemon and C. aurantium. It is also revealed from the reports so far received that lime, lemon, pummelo are grown all over Bangladesh while mandarin and sweet oranges are grown only in the north eastern region of Bangladesh. This method, however, failed to locate plants of outstanding qualities for collection and evaluation belonging to the afore-said species. It is, therefore, suggested that the scientist working in the project should go out on tour to the important citrus growing localities for the selection of mother plants and collection of scion from them. Further action in progress.

Experiment No. 2.

(1) Collection and study of local citrus varieties.

Researcher: H. Daito, A. M. Abdullah, and
Sanaullah Mollah.

Objective: To collect germplasm of outstanding plants as well as wild unknown species/varieties.

Materials and Methods:

Plants of outstanding qualities were located through personal contact and the scion was collected from those plants in the nursery. Seeds of wild and unknown species were also looked at in the market.

Results and Discussions:

As many as three new lemon varieties, three pummelo varieties and two rootstock species were collected from June 1981 to August, 1983. These varieties are in addition to the varieties

reported earlier by Mr. Y. Koderu, Japanese citrus expert in his final report.

- (1) Lime and Lemon
 - a) Kagzi lebu (round)
 - b) Kagzi lebu (oval)
 - c) Sashmi lebu

- (2) Pummelo:
 - a) North Bengal sugar mill (white)
 - b) North Bengal sugar mill (red)
 - c) Jamalpur (1)

- (3) Rootstock species
 - a) Satkara (C. macroptua)
 - b) Rough lemon (C. Mediah)

These varieties are being grown with other exotic cultivars for evaluation.

Experiment No. 3.

- (1) Title: Introduction and evaluation of different exotic species of citrus and their relations.

Researcher: H. Daito, A. M. Abdullah, and Sanaullah Mollah.

Objective: Selection of improved varieties adaptable to the agroclimatic condition of Bangladesh.

Materials and Methods:

Vrious exotic citrus species have been collected from different countries with the help of JICA and to some extent by the BARI scientists. The collected materials are mostly planted at the citrus introduction block at Joydebpur Station for observation.

Results and Discussion:

Attempts were made to contact various citrus research station around the world for the collection of new citrus cultivars. The following varieties were collected during June, 1981 through January, 1982. These are in addition to the 106 varieties reported to have been introduced in Bangladesh in the final report of Mr. Y. Koderu.

LIST OF INTRODUCED VARIETIES

- | | |
|----------------------------|---|
| (A) <u>Mandarin orange</u> | (D) <u>Other citrus varieties/species</u> |
| a) Taiwan ponkan | (a) Rough lemon |
| b) Pong orange | (b) Rangpur lime |
| c) Nan fang mi-orange | (c) Cleopatra mandarin |
| d) Nagpuri orange | (d) Sour orange |
| e) Khasia orange | (e) Natsudaiddai |
| (B) <u>Sweet orange</u> | (f) Sankitsu |
| a) Sin hui orange | (g) Tachibana |
| b) Lui orange | (h) Hong pi suan |
| c) Hua zho orange | |
| (C) <u>Lime and lemon</u> | |
| a) Calamansi | |

- (2) Title: Introduction and evaluation of different exotic citrus rootstock varieties and their relatives

Researcher: A. M. Abdullah, S. Mollah, and H. Daito

Objective: Selection of the improved rootstock varieties adaptable to agro-ecological conditions of Bangladesh

Materials and Methods:

Seeds of rootstock varieties were collected from United States of America, Japan and India. The collected seeds are as follows.

1. Carrio citrange
2. Cleopatra mandarin
3. Sour orange #2
4. Swingle citrumelo and
5. Rough lemon from United States of America
6. Rough lemon
7. Rangpur lime
8. Cleopatra mandarin
9. Sour orange
10. Natsudaiddai and
11. Sankitsu from Japan.
12. Eddanambu from India.

After seeds were dipped in the Difar solution to protect diseases, sown sandy soil nursery bed on 14 April, 1982.

Germination percentage of each variety was approximately 95%.

When plants grew about 10 cm height, they were transplanted in big porous pots containing fertilized soil.

Results and Discussion:

Initial growth of Rangpur lime, Eddanambu and Rough lemon were vigorous, Sankitsu and Cleopatra mandarin were little week.

We can use each rootstock regarding with heir characters.

Table 1 Growth of rootstock seedlings (12 June, 1982)

Variety	Plants height	No. of leaves
1. Carrio citrange	11.5	13.0
2. Cleopatra mandarin	7.5	12.0
3. Sour orange #2	10.5	13.0
4. Swingle citrumelo	13.8	14.0
5. Rough lemon (U.S.A.)	13.8	12.0
6. Rough lemon (Japan)	13.6	13.0
7. Rangpur lime	16.6	17.0
8. Cleopatra mandarin	7.0	14.0
9. Sour orange	11.4	14.0
10. Natsudaidai	11.3	13.0
11. Sankitsu	4.6	8.0
12. Eddanambu	15.6	15.0

(3). Title: Introduction and evaluation of different exotic varieties and their relatives

Researcher: A. M. Abdullah, S. Mollah, and H. Daito

Objective: Selection of the improved varieties adaptable to agro-ecological condition of Bangladesh

Materials and Methods:

Scion of various citrus varieties were collected from Japan on 24 January, 1982.

Varieties are as follows;

1. Ihara ponkan 2. Tosa buntan 3. Hirato buntan 4. Hassaku No. 55 5. Hyuganatsu 7. Kawanonatsudaidai 8. Kuno unshu 9. Nankan No. 20 10. Miyauchi iyo 11. Seto unshu 12. Kunenbo and 13. Marsh grapefruit

Scion were kept in refrigerator covering polyethylene film bags with moist cotton up to the date of grafting.

Rootstocks were two years old of local pummelo. The scion for grafting were selected with one bud only and in field condition were kept in petridish under moist cotton. Generally the scion

and rootstock were chosen with equal diameter.

Scion were grafted at side of rootstock trunk on 10 March, 1982. Polyethylene tape was used in grafting. Grafting tape was opened after two months.

Furthermore, seeds of Malta orange and Nagpur santra were collected from Pakistan and India, respectively. Seeds were dipped in Difar solution to protect diseases, then sown the porous pots containing sandy soil on 20 February, 1982.

Germination percentage of both variety was approximately 90%.

Results and Discussion:

Success percentage of grafting is given in Table 1. The mean success percentage of grafting was 90%. This high percentage of success of side grafting in these varieties of different citrus species is quite encouraging.

Table 1 Percentage of success in side grafting

Variety	% success	Variety	% success
Ihara ponkan	80	Kuno unshu	100
Tosa buntan	100	Nankan No. 20	70
Hirato buntan	100	Miyauchi iyo	80
Hassaku No. 55	100	Seto unshu	90
Hyuganatsu	80	Kunenbo	80
Kawano natsudaidai	100	Marsh grapefruit	100

Initial growth of Malta orange and Nagpur santra seedlings is given in Table 2.

Table 2 Growth of seedlings (12 June, 1982)

Variety	Plant height	No. of leaves
Malta orange	7.0	13.0
Nagpur santra	3.6	7.0

The seedlings have now attained suitable size for grafting, they will be grafted with some scion varieties.

- (4) Title: Studies on the morphological and reproductive characteristics of exotic citrus varieties.

Researcher: H. Daito, and Sanauallah Mollah

Objective: A large number of citrus varieties belonging to all the commercially important species have been collected from Japan and other neighbouring countries. Evaluation of vegetative and reproductive characters of these varieties is a pre-requisite for selection and recommendation.

Materials and Methods:

Five to 10 plants from each of the commercially important citrus varieties were planted in lines in the Main Centre at Joydebpur during 1979-'80. Plants were spaced 4 meter apart on both way. Necessary cultivation were done in order to maintain optimum condition for plant growth. Three plants from each variety were selected for taking data on plant height, base girth, spread and fruit yield per plant. The morphological characters were recorded in December, 1981 while fruit yield was counted in August, 1982.

Results and Discussion:

Data from 18 mandarin, 11 sweet orange, 14 pummelo and 3 lemon varieties in respect of different morphological reproductive and qualitative characters were recorded and presented in Table 1, 2a and 2b. From the table it is revealed that the variety Okitsu wase produced most vigorous plant having maximum height (160.60 cm), spread (2.78 sq. meter) and base girth (16.80 cm), and followed by Miho wase, Miyagawa wase. Among the 18 varieties of sweet orange investigated only five varieties have produced fruit in 1982. Harvesting of fruits were done in October and November, 1982. The counting of fruits in order to ascertain the yield per plant were done in August, 1982. The maximum number of fruit per plant was obtained in Miho wase (11.16) followed by Kinkogi unshu (7.5), Okitsu (6.87) and Juman unshu (3).

Table 1 Morphological and reproductive characters

Variety	Plant height (cm)	Base girth (cm)	Spread (m ²)	Fruit/plant
1	2	3	4	5
A. Mandarin				
1. Kinnow	89.44	9.66	0.48	-
2. Satsuma	101.75	10.12	0.48	-
3. Miyagawa wase	14.2	14.25	1.31	-
4. Okitsu wase	160.60	16.80	2.78	6.87
5. Miho wase	146.33	15.33	2.55	11.16
6. Ishikawa unshu	90	6.50	0.55	-
7. Sugiyama unshu	83.75	11.25	0.54	-
8. Tanikawa unshu	116.53	7.23	0.87	-
9. Kinkoji unshu	103.18	7.18	0.47	7.5
10. Hayashi unshu	88.07	6.15	0.73	-
11. Yamada unshu	101.11	6.25	0.58	-
12. Tagami unshu	96.53	5.53	0.37	-
13. Kunenbo	66.50	5.30	0.27	-
14. Silverhill	101.53	6.84	1.08	-
15. Juman unshu	94.09	6.72	0.10	3
16. Ponkan santra	63.75	5	0.15	-
17. Ponkan-F 242	56.25	5	0.08	-
18. Imazu-Ponkan	32.50	4.50	0.01	0
B. Sweet Orange				
19. Valencia orange (SA)	137.5	13.0	1.74	-
20. Jaffa (S.O.)	125.37	11.00	0.66	3.0
21. Mosambi	94.66	9.44	0.39	2.0
22. Suckery	97.37	10.25	0.52	3.0
23. Blood red	90.75	8.37	0.25	-
24. Pineapple	214.42	16.42	0.99	-
25. Kin-Kunenbo	80	5.33	0.18	7.16
26. Omishima navel	97.50	8.22	0.28	1.66
27. Shiroyanagi navel	187.50	6.50	0.44	-
28. Narita navel	63.57	5.14	0.21	-
29. Kanton orange	58	6.40	0.15	-

	1	2	3	4	5
C. <u>Pummelo</u>					
30.	Hyuganatsu (P)	100.11	8.44	0.49	23.00
31.	Benihassaku	115	15.16	1.28	5.75
32.	Anseikan	92.72	7.09	0.55	2.5
33.	Kobayashi mikan	101.66	7.75	0.53	-
34.	Banwokan	62	5.60	0.18	-
35.	Red Blush	75.90	6.18	0.44	-
36.	Marsh grapefruit	100	7.28	0.50	-
37.	Tosa buntan	107	8	0.35	-
38.	Bampeiyu	50	5.50	0.18	-
39.	Matoh buntan	35	3.33	0.05	-
40.	Amanatsukan	105.83	9.33	0.43	7.75
41.	Kawachi bankan - A	97.22	8.00	0.35	6.5
42.	Kawachi bankan - B	93.87	9.62	0.49	-
43.	Sambokan	170.11	14.55	1.64	-
D. <u>Lime and Lemon</u>					
44.	Lisbon	215.28	20.14	2.48	6.5
45.	Eureka	175.33	14.33	1.48	1.0
46.	Villafranca	193.25	15.25	1.38	-

(Average of three good plants)

Fruit drop as a matter of routine work was recorded. Fruit characteristics of cultivars were also determined from directly harvested fruit. Data of fruit characteristics of different citrus varieties obtained in this trial is shown in Table 2a and b.

Table 2a Fruit characteristics of different citrus varieties

Variety	Whole fruit			Without skin		Flesh Wt. with seed (g)	Skin Wt. (g)
	Wt. (g)	Length (cm)	Width (cm)	Length (cm)	Width (cm)		
A. <u>Local lime and lemon</u>							
1. Kagzi	34.17	4.40	3.92	3.65	3.60	26.37	7.37
2. Seedless	57.50	6.50	4.30	4.75	3.60	31.70	25.30
3. Elachi	69.60	5.42	4.90	4.77	4.52	54.20	14.87
B. <u>Exotic cultivars</u>							
4. Lisbon	75.25	6.20	4.80	4.70	4.30	50.00	28.85
5. Miho wase	302.85	8.26	8.47	6.00	7.24	114.73	78.19
6. Okitsu wase	180.51	8.24	8.17	5.91	8.95	106.62	74.48
7. Anseikan	721.50	10.45	11.60	8.50	10.40	559.50	207.25
8. Kin kunenbo	95.06	5.55	5.60	5.10	5.00	72.40	21.23
9. Hyuganatsu	100.55	5.92	5.84	4.49	5.21	67.06	32.66
10. Kinkoji	315.20	9.25	8.50	8.00	7.55	223.00	81.15
11. Amanatsukan	463.50	8.30	10.10	7.80	9.50	364.30	95.80

Date of harvest: 21. Nov. 82

Table 2b Fruit characteristics of different citrus varieties

Variety	Thickness of rind (cm)	Juice content (ml)	Acid (%)	Brix (%)	Remarks
A. <u>Local lime and lemon</u>					
1. Kagzi	0.2	9.00	4.37	7.02	
2. Seedless	0.40	9.75	5.65	6.60	
3. Elachi	0.27	13.87	4.96	5.85	
B. <u>Exotic cultivars</u>					
4. Lisbon	0.52	13.50	4.55	6.00	
5. Miho wase	0.53	24.00	-	7.43	
6. Okitsu wase	0.47	21.00	0.38	7.36	
7. Anseikan	0.85	35.5	0.63	7.40	
8. Kin kunenbo	0.36	24.0	1.01	10.33	
9. Hyuganatsu	0.51	37.00	2.25	8.07	
10. Kinkoji	0.65	41.00	0.74	6.00	
11. Amanatsukan	0.70	240.00	1.46	9.20	

Date of harvest: 21. Nov. 82

(5) Title: A comparative study of six lemon cultivars grafted on pummelo rootstock.

Researcher: A. M. Abdullah, H. Daito, and Ashraf Khan

Objective: To study the performance of some lime and lemon cultivars grafted on pummelo rootstock.

Materials and Methods:

Three exotic cultivars namely; Lisbon, Eureka, Villafranca and three local cultivars namely Kagzi, Elachi and Seedless lemon were grafted on one year old pummelo seedlings; already planted in the field, in June, 1981. Characters like graft union, plant height, spread, base girth, number of leaves flowering and fruiting were studied.

Results and Discussions:

(a) Graft compatibility

Graft union was completed very quickly and new sprouts were found to emerge out from the within about 3 to 4 weeks time. 100 percent success in graft union was recorded in this study in all the cultivars except Kagzi lebu which had 90% success only (Table 1).

Table 1 Percent success in grafting of three exotic and three local lemon and lime cultivars.

Variety	No. of grafts made	No. of successful graft union	Percent of success (%)	Remarks
Eureka	10	10	100	-
Lisbon	10	10	100	-
Villafranca	10	10	100	-
Kagzi	10	9	90	-
Elachi lebu	10	10	100	-
Seedless	10	10	100	-

Date of grafting: 15 June, 1981 Date of collection 30 July, 1981

(b) Growth parameters

The vegetative and reproductive characteristic were recorded at an interval of 2 months. The data pertaining to these characters.

as obtained on 9 July, 1982 are presented in Table 2.

Elachi lebu was found to grow quickly and produce maximum vegetative growth in respect of base girth (17.06 cm), number of leaves (2516.83/plant) and spread (2.14 m²) while the minimum vegetative growth was obtained in case of kagzi lebu.

The exotic cultivars showed a tendency to grow erect compared to the local cultivars. The maximum plant height was obtained in Villafranca (144.5 cm) followed by Eureka (131.5) and Lisbon (116.5). Again in respect of base girth, spread and number of leaves, these exotic cultivars maintained similar order and could be ranked second, third and fourth among the six cultivars.

Table 2. Some vegetative and reproductive characteristics of six lime and lemon varieties

Variety	Base girth (cm)	Height (cm)	Spread (m ²)	No. of leaves	No. of fruits
Elachi lebu	17.06	108.5	2.14	2516.83	25.33
Kagzi	9.95	68.83	0.43	456.83	6.66
Villafranca	16.16	144.5	1.47	1891.16	0
Lisbon	11.75	116.5	1.24	1216.16	0
Seedless	13.38	92.33	0.72	613.00	3
Eureka	14.85	131.5	1.69	1369.16	0

Data obtained on 9 July, 1982

Average of 6 plants

The local cultivars bore some fruits in about a year time. The maximum number of fruit were recorded in Elachi lebu (25.33 per plant) followed by Kagzi (6.66) and Seedless (3.00). The exotic varieties are yet to produce any flower or fruits. Although it is very early to make any comments on the performance of these cultivars but it can be said that the growth of these varieties on pummelo rootstock is quite encouraging.

(6) Title: Evaluation of various pummelo varieties including exotic and local varieties when grafted on pummelo rootstock.

Researcher: A. M. Abdullah, A. K. M. Amzad Hossain, and H. Daito

Objective: The pummelo varieties introduced from Japan are grafted on trifoliolate orange rootstock. The plants grown on trifoliolate

orange roots may not thrive well under Bangladesh condition. On the other hand, local pummelo plants are found to grow well all over Bangladesh. They have also extensive root system. Until now it is regarded as the number of rootstock in Bangladesh. It is, therefore, felt necessary to test the performance of the promising exotic and local pummelo cultivars when grafted on local pummelo rootstock.

Materials and Methods:

Fifteen exotic and two local cultivars of pummelo group were included in this study. The experiment was designed in a completely randomized design replicated 5 times, one plant representing a treatment. There were five rows 5 meter apart and the plants were spaced 4 meter within rows. The name of the varieties included in this trial are appended below.

List of varieties

- | | |
|-------------------|--------------------------------|
| (1) Anseikan | (9) Noma beni hassaku |
| (2) Banokan | (10) Hassaku-55 |
| (3) Hirato buntan | (11) Thailand (W) |
| (4) Wase hassaku | (12) Otachibana |
| (5) NBSM (W) | (13) Marsh Seedless grapefruit |
| (6) WBSM (R) | (14) Kaopan |
| (7) Suisyo buntan | (15) Tosa buntan |
| (8) Banpeiyu | (16) Mato buntan |
| | (17) Shin amanatsu |

Results and Discussion:

The experiment was initiated in April, 1982. The initial results indicated that the graft compatibility of these varieties with local pummelo rootstock are quite high. Proper care and management is being done to keep the plants at optimum grow condition.

(7) Title: Introduction and evaluation of exotic citrus cultivars grafted on trifoliolate rootstock at the Sub-Centre, Ishurdi

Researcher: H. Nagai, Jamiul Islam, and H. Daito

Objective: To evaluate the performance of exotic Japanese citrus cultivars grafted trifoliolate orange rootstock under the agro-ecological condition in Ishurdi region.

Materials and Methods:

Thirtyeight different citrus cultivars received earlier from Japan and rared at the nursery of Main Centre at Joydebpur were despatched to Ishurdi for regional trial in July, 1982. Five plants from each of the varieties were planted in line immediately after receipt. The name of the varieties furnished is given below.

A. Mandarin

- (1) Tachibana
- (2) Kishumikan
- (3) Matsuyama wase
- (4) Yoshida ponkan
- (5) Nankan No. 20
- (6) Batangas
- (7) Hashimoto wase
- (8) Aoshima unshu
- (9) Tanikawa unshu
- (10) Kinkoji unshu
- (11) Hayashi unshu
- (12) Tankan
- (13) Kobayashi mikan
- (14) Silberhill
- (15) Juman unshu

B. Sweet Oranges

- (1) White Silleta
- (2) Hamlin orange
- (3) Fukuhara orange
- (4) Omishina navel O.

C. Hybrids

- (1) Seminole
- (2) Thornton
- (3) Allspice
- (4) Akitsu No. 21

D. Pummelo

- (1) Natsukan
- (2) Hassaku No. 55
- (3) Kopan
- (4) Otachibana
- (5) Hirato buntan
- (6) Beni hassaku
- (7) Wase hassaku
- (8) Shin amanatsu
- (9) Mato buntan
- (10) Iyokan
- (11) Kuno unshu
- (12) Suisyo buntan
- (13) Sankitsu

E. Others

- (1) Royal lemon
- (2) Trifoliolate orange

Results and Discussion:

Optimum care and management are given to the plants. They are still very young to make any comment.

(8) Title: Evaluation of exotic citrus cultivars on regional basis at the Sub-Centre, Ishurdi when grafted on pummelo rootstock.

Researcher: H. Nagai, Jamiul Islam, and H. Daito.

Objective: To study some promising Japanese citrus varieties when grafted on pummelo rootstock. It may be noted that the exotic Japanese citrus varieties are grafted on trifoliolate rootstock the roots of which may not grow well under the climatic condition of Bangladesh. One such study is being done at the Main Centre at Joydebpur, so, it is felt necessary to evaluate the new varieties in the northern part of the country on local pummelo rootstock.

Materials and Methods:

Scion of 24 exotic citrus varieties were supplied to Ishurdi Sub-Centre from Dhaka in February, 1982. Grafting operations were performed on pummelo seedlings on 16, 18, 19 and 22 February. Ten grafting were done in each variety.

Results and Discussion:

Percentage of success of graft union is shown in Table (1). The percentage of success obtained in this case ranged from 30 to 90 percent which may be considered as high for nurserymen. The successful grafts have been planted in the field for further observation.

Table 1 Percentage of success of union.

Sl. No.	Variety	Period of grafting	Number of grafting done	No. of successful graft	Percent success
1.	Ishikawa unshu	3rd week of February 1982	10	5	50.00
2.	Natsukan	-	10	5	50.00
3.	Miyagawa wase	-	10	5	50.00
4.	Anseikan	-	10	5	50.00
5.	Tanikawa unshu	-	10	6	60.00
6.	Wase hassaku	-	10	7	70.00
7.	Hirato buntan	-	10	7	70.00

Table 1 (Continued)

Sl. No.	Variety	Period of grafting	Number of grafting done	No. of successful graft	Percent success
8.	Matsuyama wase	-	10	6	60.00
9.	Noma beni hassaku	-	10	7	70.00
10.	Shin amanatsu	-	10	7	70.00
11.	Hassaku No. 55	-	9	3	33.33
12.	Yoshida navel	-	9	4	44.44
13.	Omishima navel	-	10	5	50.00
14.	Aoshima unshu	-	10	9	90.00
15.	Kuno unshu	-	8	5	62.00
16.	Miho-wase	-	10	6	60.00
17.	Iyokan	-	9	5	55.55
18.	Kaopan	-	10	3	30.00
19.	Allspice	-	10	3	30.00
20.	Sugiyama unshu	-	7	3	42.82
21.	Okitsu wase	-	13	8	61.5
22.	Otachibana	-	8	4	50.00
23.	Thornton	-	6	4	50.00
24.	White Siletta	-	3	1	33.33

Experiment No. 4.

Development of appropriate nursery technique for raising and maintaining of rootstock seedlings.

(1) Title: Effect of different methods of storage on germination of pummelo seeds.

Researcher: H. Daito, and Ashraf Khan

Objective: To evaluate the effect of storage methods in prolonging the viability of pummelo seeds.

Materials and Methods:

Seeds were extracted from pummelo fruits on 2 October, 1981. The seeds were then washed in water and air dried at room temperature for 24 hours. Uniform sized seeds were selected for this experiment and divided into two groups. One group was stored at 5°C in a refrigerator in polyethylene bags while the other group was stored at room temperature in a desiccator.

100 seeds from each storage were planted per earthen pot on 2 November, 4 December, 15 January and 8 February. Seeds from each of the two storage methods were planted in two pots in each planting.

Results and Discussion:

The result is presented in Table 1. It is revealed that the seeds stored at low temperature and room temperature retained their viability to a satisfactory level at the end of one month storage as indicated by 72 and 58 percent germination of seeds respectively. The seeds thereafter, lost their viability quickly and 21 and 4 percent germination was recorded 2 months after storage at low and room temperature respectively. However, no viable seed could be detected at the end of 4 months storage. Low temperature did not appear to help very much in retaining seed viability of pummelo to any length of storage period.

Table 1 Percentage of germination in pummelo seed stored at low and room temperature

Planting	Germination percentage	
	Low temperature	Room temperature
2 November, 1981	72	58
4 December, 1981	21	4
15 January, 1982	12	2
8 February, 1982	0	0

Date of seed extraction: 2 October, 1981

(2) Title: Effect of fungicidal treatments on germination and production of albino seedlings of pummelo.

Researcher: H. Daito, Ashraf Khan, and Sanaulah Mollah

Objective: To study the effect of fungicides on germination and production of albino seedlings.

Materials and Methods:

There were six fungicides viz-Difar, Topsin-M, Benlate Vitavex-200, Vitavex-300 and Hamai in this study. Seeds of local pummelo were extracted and soaked in freshly prepared 0.5% solution of these fungicides for one hour on 15 October, 1981. Immediately after soaking, 50 seeds were sown in one big earthen pot repre-

senting one treatment. There was also one untreated control. The experiment was replicated two times.

Results and Discussion:

Percent germination and emergence of albino seedlings were recorded on 7 January, 1982. The data are presented in Table 1.

Table 1 Percent germination and emergence rate of albino seedlings

Treatment	Percent germination	Emergence of albino seedlings
Difar	70	2
Topsin-M	71	6
Benlate	76	9
Vitavex-200	77	5
Vitavex-300	75	5
Hamai	80	8
Control (Soaking in tap water only)	46	7

Date of Sowing: 13 October, 1981 Date of obtaining data: 7 January 1982

It is apparent that the fungicidal treatment have significantly increased the percentage of germination irrespective of kind or type of fungicides. But in respect of emergence of albino seedlings, the treatments seemed to have no influence. Hence, fungicidal treatments of pummelo seeds may be recommended for greater seed germination.

(3) Title: Effect of size of pummelo seeds on the germination ability and subsequent development of plants.

Researcher: H. Daito, Ashraf Kahn, and Sanaulla Mollah

Objective: Local pummelo is now being used as rootstock for many citrus species and rootstock plants are always raised from seeds. It is known that seed vigour plays an important role on germination and subsequent development of plants. The study was, therefore, undertaken to find effect of seedsize on the germination ability and subsequent development of plants.

Materials and Methods:

Seeds were extracted from the locally collected pummelo fruits and were washed and dried and grouped into five grades according

to length-breadth (L/B) ratio, per seed weight and seed volume as shown in Table 1. The seeds were then stored in the refrigerator for two weeks before sowing. 100 seeds of each group

Table 1 Five grades of pummelo seeds

Grades	L/B ratio	Weight per seed (mg)	Volume per seed (cm ³)	Number of seeds per litre
1	2.09	6.08	0.01	67,166
2	2.04	13.33	0.02	18,409
3	2.29	50.36	0.07	5,620
4	1.82	317.05	0.34	1,250
5	1.95	400.86	0.43	977

were sown on 15 October, 1981 in earthen pots for germination. The number of seeds germinated were counted on 7 December. 10 seedlings of each group were uprooted on 19 December, 1981 to note stem and root length and weight of plants.

Results and Discussion:

Data with respect to percentage of germination in seeds of different grades are presented in Table 2. It revealed that smaller seeds as in grade-1 and grade-2 do not have the ability to germinate at all. The germination ability of grade-3 seeds is also very poor and cannot be used for raising plants. However, there were 75 and 87% in germination of grade-4 and grade-5 seeds which are considered very satisfactory.

Table 2 Percent germination of different grades of pummelo seeds

Grade of seeds	Number of seeds sown	Number of seeds germinated	Per cent germination
1	100	0	0
2	100	0	0
3	100	5	5
4	100	75	75
5	100	87	87

The data with respect to stem and root length and weight of plants of grade-4 and grade-5 seeds are presented in Table 3. The plants of grade-5 seeds were found to be superior to those of grade-4 seeds with respect to plant weight and stem and root length. It may be concluded from the result that only bigger seeds should be planted to get strong and vigorous plants.

Table 3 Stem and root length and weight of plants as affected by seed size

	Length of root (cm)	Length of stem (cm)	Weight of 10 plants (g)
Grade-4			
Plant No. 1	13	7	
2	10	7	
3	12	7	
4	14	7	
5	12	8	8.0
6	11	7	
7	11	9	
8	9	8	
9	10	8	
10	10	8	
Mean	11.2	7.6	
Grade-5			
Plant No. 1	10	8	
2	12	10	
3	11	8	
4	15	9	
5	14	10	14.0
6	13	11	
7	13	10	
8	13	9	
9	12	8	
10	12	8	
Mean	12.5	9.1	

(4) Title: Effect of medium soil and baking of medium soil on rooting of pummelo and Yuzu cutting and germination of pummelo seeds.

Researcher: H. Daito, Sanauallah Mollah, and A.M. Abdullah

Objective: To evaluate the effect of media and baking of media on the germination of pummelo seeds and rooting of pummelo and Yuzu stem cuttings.

Materials and Methods:

Six types of medium soil were included in this experiment namely; sand, sand+field soil, field soil, paddy field soil, citrus orchard soil and soil with cow-dung. These six type of media were again grouped into two viz-baking and non-baking. Baking of media were done on 13 October, 1981. Big earthen pots were then filled with baked and non-baked and non-baked media and levelled properly. Fifty cuttings from one year old pummelo and Yuzu plants were taken, each 15 cm long and planted in a pot. There were two such pots for each treatment representing two replications. Cuttings were planted in the pots very closely at an angle of about 60°.

Fifty uniform sized pummelo seeds were also sown in each pot filled with six kinds of baked and non-baked soil media.

Results and Discussion:

The result is shown in Table 1. On close examination the data revealed that there was no appreciable difference in germination and root development of pummelo seeds and in the root development of pummelo and yuzu cuttings due to various soil media used in this study. Baking of media also appeared to be unnecessary. So, any of these soil media may be used in the nursery without baking.

Table 1 Percent success of pummelo and Yuzu stem cuttings and pummelo germination and root development of pummelo seeds in six different medium soil

Media	Percent success of pummelo stem cuttings		Percent success of Yuzu stem cutting		Percent germination of pummelo seeds	
	Baking	Non-baking	Baking	Non-baking	Baking	Non-baking
Sand	25	30	35	25	52	56
Sand+field soil	15	55	45	20	50	54
Field soil	25	45	30	50	68	54
Paddy field soil	25	40	40	35	44	44
Citrus orchard soil	40	60	50	40	46	44
Soil with cow dung	Not done	10	Not done	10	Not done	64

(5) Title: Effect of medium soil on the root development of stem cutting of some local lime, lemon and pummelo varieties.

Researcher: H. Nagai, Jamiul Islam, and H. Daito.

Objective: To determine the effectiveness of various medium soil for the propagation of Elachi lemon (*C. Mediea*), Seedless lemon (*C. limon*), Kagzi lime (*Y. aurantifolia*) and pummelo (*C. grandis*); the popular citrus cultivars of Bangladesh through stem cutting.

Materials and Methods:

Effectiveness of 10 different types of medium soil like (a) sand, (b) sand (burnt), (c) rice field soil, (d) rice field soil (burnt), (e) lemon garden soil, (f) lemon garden soil (burnt), (g) vegetable soil+sand, (h) vegetable soil+sand (burnt), (i) vegetable soil+cow-dung and (j) vegetable soil cow-dung (burnt) were tested for the rooting of stem cutting of Elachi lemon, Seedless lemon, Kagzi lime and local pummelo varieties. Burning was done in ordinary pan and fire. Ten earthen pots were filled 10 different type of media and cuttings of one cultivar were planted in all of these 10 pots. There were such group for each variety. Ten cuttings were planted per pot.

Results and Discussion:

The cuttings of each kind of citrus were planted on April 1, 1982 and the data pertaining to the percent success was recorded on June 30, 1982 i.e. after 90 days and reported in Table 1. The experiment was conducted at the Sub-Centre, Isburdi.

Table 1 Percent success of stem cutting

Media	Elachi lemon	Seedless lemon	Kagzi lime	Local Pummelo	Remarks
1. Sand	73.33	20.00	0	0	-
2. Sand (burnt)	6.66	33.33	0	0	-
3. Rice field soil	33.33	46.66	0	13.33	-
4. Rice field soil (burnt)	13.33	13.33	0	0	-
5. Lemon garden soil	6.66	20.00	0	13.33	-
6. Lemon garden soil (burnt)	6.66	0	0	0	-
7. Vegetable soil + sand	26.66	20.00	0	0	-
8. Vegetable soil + sand (burnt)	33.33	6.66	0	0	-
9. Vegetable soil + cowdung	20.00	13.33	0	0	-
10. Vegetable soil + cowdung (burnt)	6.66	0	10.00	0	-

Elachi lemon

Highest percentage of success (73.33%) was obtained with sand while the lowest percentage of success was encountered with sand (burnt), lemon garden soil of both kinds and vegetable soil + cowdung (burnt) (6.66). So sand may be regarded as better medium soil for the rooting of Elachi lemon stem cuttings.

Seedless lemon

In case of seedless lemon, the highest percentage of success (46.66%) was obtained in rice field soil while no success were recorded in lemon garden soil (burnt) and vegetable soil + cowdung (burnt). Subject to further investigation one may use rice field soil for the rooting of seedless lemon cuttings.

Kagzi lime and Pummelo

Almost nil percentage of success were obtained in all the medium soil for both the citrus varieties. So it is not possible for the nurseryman to propagate these two cultivars through stem cutting with the existing knowhow.

(6) Title: Relation between tree growth and rootstock root system in citrus

Researcher: A. M. Abdullah, S. Mollah and H. Daito

Objective: Citrus seedlings are generally transferred from nursery bed to field to make citrus groves. When seedlings are digged from

the nursery bed, some tap, lateral and fibrous roots are removed, so the trees sometime do not grow vigorously and the root system becoming narrow and shallow after planting. It is important to investigate the relationship between tree growth and rootstocks root system.

Materials and Methods:

Five rootstock varieties were included in this trial namely Yuzu, Trifoliolate orange, Elachi lemon, Adhajamir and Pummelo. There were three types of rootstock (1) with full tap root (2) tap root half cut (3) saplings raised from cuttings. Scion of Tosa buntan were grafted on each kind of rootstock on May, 1982. The grafted seedlings were transplanted in field on 29 July, 1982.

Results and Discussion:

The plants are very small. Necessary care are being taken regularly.

(7) Title: Study to find out best time and method of grafting in various rootstock varieties.

Researcher: H. Daito, A. M. Abdullah, and Sanaulah Mollah.

Objective: The common method of grafting now being used in many countries for the propagation of citrus species are veneer grafting, side grafting and T-budding. Again these methods are dependent rootstock species scion variety and the climatic condition of a country. This study was undertaken to find out the best method of grafting and the optimum period of operation for each some rootstock variety.

Materials and Methods:

Three rootstock varieties namely pummelo, lemon and Adhajamir were included in this experiment. The scion variety used was Mihowase, a famous Japanese mandarin. The grafting was done at 2 months interval starting from February, 1982. The last one being done in November 1982. Ten grafting were done in each case.

Table 1 Percentage of success of grafting

Item	Percent success %				
	Date of grafting				
	23 February	5 May	6 July	5 September	11 Nov. 1982
Pummelo x Mihowase					
a) Side grafting	10%	20%	50	-	20%
b) Veneer grafting	40	0	20	-	20
c) T-budding	90	0	0	-	00
Lemon x Mihowase					
a) Side grafting	60	30	10	-	0
b) Veneer grafting	10	80	80	-	0
c) T-budding	50	0	0	-	0
Adhazamir x Mihowase					
a) Side grafting	50	10	60	-	0
b) Veneer grafting	10	0	20	-	0
c) T-budding	100	0	0	-	0

Results and Discussion:

The result obtained in this trial is presented in Table 1. The percentage of reasonable success in February whereas the result obtained on other season is erratic. However side grafting was found to be better in most season in all the three rootstock varieties trial.

Experiment No. 5

Comparative study of propagating lime, lemon and pummelo through budding and grafting against airlaying and cutting.

(1) Title: Studies on the multiplication of some citrus rootstock species through stem cutting.

Researcher: H. Daito, Ashraf Khan, and Sanaullah Mollah

Objective: Plants raised from seeds are used as rootstock but these seedlings are not likely to be true to type. Since rootstock plants also influence the quality of fruit, so identical rootstock plant are desired. Hence, the work was undertaken to study the feasibility of multiplying the rootstock species through stem cutting which is considered to be a very easy and cheap method of vegetative propagation. The second objective is to identify

proper time of making cuttings of these citrus species.

Materials and Methods:

Pummelo (Citrus grandis), Adhazamir (Citrus aurantium), Yuzu (Citrus junos) and Trifoliate orange (Poncirus trifoliate) were included in this study. Three of kinds of shoots viz new shoots, one year old shoots and 2 year old shoots were used for cuttings. Twenty or twentyfive cuttings were prepared in each case and planting was done in every alternate month starting from July, 1981 through May, 1982.

Results and Discussion:

The result is presented in Table 1. Adhazamir was found to be quite amenable to stem cutting and gave very high percentage of success irrespective of the age of shoot and time of planting. Pummelo cuttings were quite successful in November and January plantings, while Yuzu and trifoliate orange cuttings showed high percentage of success in March and May plantings respectively. Age of shoot apparently does not bear significant influence on the success of cuttings of the citrus species under study.

Table 1 Percent success of cuttings of different kinds of shoots of local pummelo, Adhazamir, Yuzu and trifoliate orange planted at different time of the year.

Citrus species	Age of shoots	Percentage of success*					
		2 July 1981	10 Sept. 1981	5 Nov. 1981	13 Jan. 1982	10 March 1982	3 May 1982
Local Pummelo	Two years	40	0	72	100	75	35
	One year	40	0	80	100	35	25
	New shoot	60	0	80	95	45	60
Adhazamir	Two years	95	100	100	100	100	100
	One year	100	100	100	95	100	100
	New shoot	95	100	100	100	100	100
Yuzu	Two years	0	5	44	32	65	0
	One year	0	5	24	60	70	0
	New shoot	8	5	32	50	45	0
Trifoliate Orange	Two year	44	65	0	80	100	85
	One year	4	0	0	45	100	55
	New shoot	4	0	0	60	95	60

* Mean of two replications having fifty cuttings in each replication

Experiment No. 6.

A study to find out a suitable rootstock for the propagation of citrus under Bangladesh condition.

(1) Title: Grafting of exotic citrus varieties on local pummelo rootstock

Researcher: A. M. Abdullah, S. Mollah, and H. Daito

Objective: Seedlings of exotic citrus varieties from Japan are almost grafted on trifoliolate orange rootstock. Trees on trifoliolate orange rootstock with narrow and shallow root system are showing slowly growth, but produce high quality fruits. Trifoliolate orange, rootstock may not smoothly grow due to lack of soil moisture under dry season in Bangladesh. Local pummelo can continue to grow under dry season, because their roots are growing widely and deeply into soil. We tried to study the success of percentage of grafting, compatibility between exotic citrus varieties and local pummelo, and their multiplication for plantation.

Materials and Methods:

Maximum one year old but tender scion were collected from field and were kept in refrigerator covering polyethylene film bags. The scion for grafting were selected with one bud only and were kept in petridish under moist cotton during operation. Generally the scion and rootstock were chosen with equal diameter. Grafting was done using with polyethylene tape on 8 to 10 March, 1982. Grafting tape were opened after two months. The final observation was noted on 5 May, 1982.

Results and Discussion:

The result of this study is presented in Table 1. These success of grafting has been found to be very high without Natsudaidai. The compatibility between each variety scion and local pummelo rootstock are yet to be observed at bearing stage. Thereafter it is also necessary to compare these compatibilities and multiplication of exotic varieties for plantation.

Table 1 Percentage of success in grafting

Variety	% success	Variety	% success
Tachibana	100	Kuno unshu	100
Batangas	100	Omishima navel o.	100
Jyuman unshu	100	Matsuyama wase	90
Kaopan	100	Daikitsu	100
Nagpuri	70	Hamlin orange	100
Hassaku No. 50	100	Yoshida navel o.	100
Dancy	100	Fukuhara orange	100
Nankan No. 20	90	Natsudaiddai	30
Tanikawa unshu	100	Tosa buntan	80
Iyokan	90	Aoshima unshu	100
Tankan	90	Anseikan	100
Ishikawa unshu	100	Kishumikan	60
Miyagawa wase	100	Allspice	100
Yoshida ponkan	90	Kinnow mandarin	80
Shinamanatsu	80	Noma beni hassaku	60
Hirato buntan	90	Banokan	100
Suisyo buntan	50	White Silleta	90
Valencia orange	100	Sugiyama unshu	80
Jyuman	100	Thornton	100
Marsh grapefruit	90	Wase hassaku	60
Okitsu wase	100	Nagpuri	100
Kunenbo	80	Mosambi	100
		Feutrell's early	60

(2) Title: Trial to select rootstock for a suitable citrus species for the agro-ecological condition of Bangladesh.

Researcher: H. Daito, Sanullah Mollah, and A. M. Abdullah

Objective: To evaluate the individual merit of six different citrus species as rootstock for all the important citrus fruits under the soil and climatic condition of Bangladesh.

Materials and Methods:

Six rootstock species such as Yuzu (Citrus-Junos), Trifoliate orange (Poncirus-trifoliate), Adahzamir (Citrus-aurantium),

Lemon (Citrus-lemon), Khasia orange (Citrus reticulata) and Pummelo (Citrus grandis) and scion of eight varieties, two from each of sweet orange, mandarin, pummelo and lime and lemon group, were included in this experiment as such there were 48 stock and scion combination. Ten grafting operations were performed in each combination in potted plants on 17-18 February, 1982. Five successful grafts from each of the 48 stock-scion combination were planted in the field on 25 June, 1982 with 5 replications to observe their performance in respect of vegetative and reproductive characters.

Results and Discussion:

The results are presented in Table 1. In respect of graft compatibility, all the stock and scion combination gave very high percentage of success except kagzi lime on trifoliolate orange (30%) and adahzamir (20%), valencia orange on trifoliolate orange (38%) and Hirato buntan on adahzamir (42%) and Yuzu (38%). The successful grafts have been planted in five replication each plant representing a treatment and observation with respect to physio-morphological characters are being taken periodically to determine ultimate stand of the grafted plants and thereby identify suitable stock-scion combination.

Table (1) Percentage of success of graft union

Scion \ Rootstock	Yuzu	Trifoliolate orange	Adahzamir	Lemon	Khasia orange	Pummelo
1. Yoshida navel	88	45	80	78	100	56
2. Valencia orange	100	38	0	100	100	100
3. Aoshima Unshu	88	100	90	100	100	86
4. Juman	100	58	90	100	100	100
5. Hirato buntan	38	50	42	100	89	80
6. Marsh grapefruit	75	100	100	75	67	90
7. Seedless lemon	67	60	80	100	100	75
8. Kagzi lime	100	30	20	100	100	80

Experiment No.7:

Effect of chemical fertilizer and organic manure on the growth and fruit yield of lemon, lime, and pummelo.

Researcher: A. Rouf, A. M. Abdullah, H. Nagai, and H. Daito

Introduction: Citrus plants require large quantities of nutrients and a supply of water throughout the year for their proper growth and fruit yield. The nutrients are fruit partly in the soil and are to be replaced from external source in order to maintain soil fertility and productivity for continuous production of high yield. In case of citrus fruit one third of fertilizer and 10 Kg of organic manure (compost of cowdung) is to be applied in the planting hole during planting and the remaining two third of the inorganic fertilizer are to be applied as top dressing after every four month. Fertilizer application in three equal installment at an interval of 4 months and measuring once a year need to be continued until the plants reach bearing stage. At bearing stage the fertilizer need to be applied in three equal doses before flowering, when new leaves and shoots are formed and during fruit growth. Application of Ca, Mg and S, and micro nutrients are required to be added depending to their status in the soil and leaves. With this back ground in viewed three separate experiments were taken up to determine suitable combination of NPK for proper growth and fruit yield of lemon, lime and pummelo under optimum cultural practices.

(1) Title: Effect of chemical fertilizer and organic manure on the growth and yield of lemon.

Objective: To determine suitable combination of N.P.K. for proper growth and fruit yield of lemon under optimum cultural practices.

Materials and Methods:

The experiment was laid out in a factorial design replicated three times. There were eight fertilizer treatments such as control, N.P.K.NP.NK.PK and NPK. The fertilizer were applied in three equal installments at an interval of four months while the organic manure were applied once in a year. The fertilizer doses were 0 and 60 g, 0 and 75 g nitrogen from Urea, 0 and 150 g, 0 and 45 g P₂O₅ from TSP, and 0 and 60 g, 0 and 45 g K₂O from muriate of potash per plant for the first and second year,

respectively. There are plants in each plot planted at 3 x 3 m spacing in square system. Planting was done on 6 August, 1980.

Results and Discussion:

Data on plant height, spread, fruit yield and size are recorded and presented in Table 1. It is revealed from the data that the fertilizer treatments tended to increase the plant height. But the increase was not statistically significant.

All the fertilizer treatments increased the spread of the plants. The highest spread (5.31 sq.m) was produced by NPK treatment which was closely followed by NK (4.33) and NP (4.00). These different were superior to control at 1% level. The other treatments except PK also produced plants with significantly larger spread.

There were two harvest. The first harvest was done on 24 October, 1981 and the second harvest on 19 May, 1982. Total yield per plot as obtained in two harvests is presented in table 1.

The highest yield (10.98 kg/plot) was obtained in NPK treatment which is superior over all other treatments at 1% level. All fertilizer treatments, in general, increased the fruit yield significantly.

The use of NPK fertilizer in combination gave the largest fruit (0.193 kg/fruit) while the smallest fruit was obtained at control (0.137).

This investigation is to be continued several years more. This is an interim report presenting the findings of the first two years.

Table 1 Characteristics of Elachi Lemon as affected by fertilizer treatments

Treatments	Plant height (cm)	Spread (m ²)	Fruit yield* (kg/plot)	Fruit **/19 May, 1982 weight (kg/fruit)
O	1.86	3.25	2.09	0.137
N	1.88	3.67	3.01	0.141
P	1.80	3.77	3.50	0.157
K	2.00	3.73	3.05	0.154
NP	1.91	4.00	4.45	0.165
NK	2.11	4.33	3.67	0.158
PK	1.88	3.28	3.82	0.157
NPK	1.95	5.13	10.98	0.193
LSD (5%)	NS	0.23	0.37	0.004
LSD (1%)	NS	0.33	0.51	0.006

Date of planting: 6 August, 1980

Date of harvest: 24 October, 1981

* Total of first and second harvest

** As obtained in second harvest

(2) Fertilizer trial with pummelo

This experiment was initiated at the Main Centre at Joydebpur with local pummelo in 1980. It was later on observed that the pummelo plants used in this trial were not uniform consequently it was decided to change the variety with a Japanese variety. Tosa buntan was selected for this purpose. Scions of this variety were grafted on local pummelo plants already planted in the field.

Materials and Methods:

Year	Fertilizer dose per plant		
	Nitrogen from urea	P ₂ O ₅ from T.S.P.	K ₂ O M.P.
1st year	0.78 (g')	0.170 (g')	0.90 (g')
2nd year	0.93	0.75	0.75
3rd year	0.141	0.120	0.99
4th year	0.180	0.165	0.165
5th year	0.270	0.195	0.270
6th year	0.342	0.270	0.330
7th year	0.480	-	0.450

Manure of 14 kg per plant were applied for 1st year and in subsequent years.

Treatment - 8, Replication - 3

- | | |
|-------------|---------|
| (1) Control | (5) NP |
| (2) N | (6) NK |
| (3) P | (7) PK |
| (4) K | (8) NPK |

Other factors and methods will be the same as followed in the trial with lemon variety

(3) Fertilizer trial with lime

This is being planned to be taken up at the Sub-Centre, Ishurdi during 1983.

Experiment No. 8

- (1) Title: Leaf analysis as a means to determine the nutrient status of various citrus plants.

Researcher: H. Daito, and Ashraf Khan

Objective: This is an attempt to develop a standard through leaf analysis for determining the fertilizer requirement and identify the causes or symptoms of unknown diseases.

Materials and Methods:

Leaf samples were collected from the healthy citrus plants belonging to different groups. The leaves of each citrus variety were washed by 0.5% acetic acid to remove all foreign materials from the surface and then oven dried. One hundred mg of dried leaves were burnt and ashes were used for making stock solution by using special chemical for determining different groups of elements. The indicator solutions were then added to the stock solution and compared against the colour chart.

Results and Discussion:

The results obtained from healthy plants of twenty citrus varieties are presented in Table 1. The results of leaf analysis of diseased and healthy plants are shown in Table 2.

The nutrient status does not appear to be different in the leaves of healthy and diseased plants which indicates that the disease like symptoms in some plants have not been produced due to nutrient deficiency.

It may be seen from the tables that the leaves of healthy plants are also deficient in phosphorus, magnesium iron, and manganese.

Table 1. Inorganic compositions of healthy citrus leaves

Variety	P(PPm)	K(PPm)	Ca(%)	Mg(PPm)	Fe(PPm)	Mn(PPm)	B(PPm)
Mihowase	Trace	2.0	1.0	0.1	25	10	30
Amanatsukan	"	1.5	1.0	0.05	50	50	40
Okitsu wase	"	2.0	0.5	0.05	10	10	30
Mossambi	"	2.0	1.0	0.15	5	10	20
Nagpuri	0.025	1.5	1.0	0.1	10	5	30
Decibre	"	2.0	0.5	0.1	5	5	40
Jaffa	"	2.0	1.0	0.15	10	25	30
Kawachi bankan	"	1.5	0.5	0.05	25	25	20
Yoshida navel O.	"	2.0	1.0	0.1	25	25	30
Miyagawa wase	"	1.5	1.0	0.05	25	25	40
Feutrell's early	"	1.5	1.5	-	5	25	-
Suckery	Trace	2.0	1.5	-	5	25	30
Hyuganatsu	0.025	2.0	1.0	-	25	50	40
Ruby red	"	2.0	0.5	-	0	10	30
Noma beni hassaku	"	2.0	0.5	-	25	10	20
Villafranca lemon	"	0.5	-	-	5	10	30
Pine apple O.	"	2.0	0.5	-	0	5	40
Iyokan	"	2.0	1.0	-	10	50	20
Sanbokan	"	1.5	0.5	-	0	10	30
Eureka lemon	"	0.5	1.0	-	0	25	20
Lisbon lemon (healthy)	0.02	2.0	1.5	0.05	5	5	40
Pine apple O. (diseased)	0.02	1.0	1.00	0.05	5	10	20
Nagpuri (diseased)	0.02	1.5	1.0	0.05	5	5	20
Mossambi (diseased)	0.02	1.0	1.0	0.05	5	5	30
Washington navel O. (healthy)	0.02	2.0	1.0	0.05	10	10	30

Experiment No. 9(1) Title: Studies on the causes and control of die-back.Researcher: M. A. Taher, and H. DaitoObjective: To identify real cause or cause of these diseases and to formulate their control measures.

Progress: This is a complex disease and minious pathogenic organisms and physiological disorder have been reported to cause this disease. Some unidentified fungi have been isolated from the diseased part of die-back infected plants. Further works on this disease are in progress.

Experiment No. 10

Title: Survey of common diseases of citrus and their seasonal abundance.

Researcher: M. Abu Taher, and H. Daito

Objective: To survey and identify incidence of various diseases on different citrus species and record their seasonal abundance.

Materials and Methods:

This study has been started in March, 1980. As a first step the incidence of diseases and their seasonal abundance on the plantations of different citrus species at Joydebpur and Jaintiapur Research Stations were recorded at one month and three months interval respectively.

The diseases were recorded by observing their typical symptoms and causal organisms of some such as canker and gummosis were identified through pathogenic tests. The degree of incidence of these diseases in the existing plantations of these two research stations were grouped into five classes viz normal (N), low (L), medium (M), high (H) and very high (VH). The seasonal abundance was determined by tabulating the periodical record of incidence of these diseases.

Results and Discussion:

Seven diseases were recorded in 29 varieties representing three different groups of citrus such as mandarin orange, sweet orange, and lime and lemon. These diseases were again grouped into major and minor depending on the degree of their incidence the summary of which is presented in Table 1.

Table (1) List of diseases their causal organisms, varietal susceptibility and seasonal abundance

Name of disease	Causal organisms	Varietal susceptibility	Seasonal abundance
<u>Major</u>			
1. Die-back	(a) <u>Fusarium sp.</u>	All the species of citrus	September to November
	(b) <u>Colletotrichum sp.</u>		
	(c) <u>Diplodia sp.</u>		
2. Citrus canker	<u>Xanthomonas Citri</u>	Lime, lemon and trifoliolate orange but mandarin and sweet oranges are less susceptible	May to November
3. Gummosis	<u>Phytophthora spp</u>	All the species of citrus	July to November
	<u>Phomopsis citri</u>		
<u>Minor</u>			
4. Citrus scab	<u>Elsinöe Fawcettii</u>	All the species of citrus	July to November
5. Wind burn	Physical	All the species of citrus	All the year round
6. Sooty mold	<u>Capnodium</u>	All the species of citrus	Except winter season
	<u>Citri</u>		
7. Melanose	<u>Diaporthe</u>	Lime, lemon and mandarin orange	All the year round
	<u>Citri</u>		
8. Greening	Mycoplasmas	-	-

Seasonal abundance:

Die-back The peak period of the incidence of this disease is from September to November. Lime, lemon, pummelo and trifoliolate orange are found to be more susceptible than mandarin and sweet oranges.

Citrus canker All groups of citrus are found to be susceptible to this disease. The peak period of this disease is found to be from May to November. However, the incidence of this disease on lime and lemon is very much prevalent throughout the year.

Gummosis

All groups of citrus are found to be susceptible to gummosis. The peak of incidence period is from July to November. This disease has been reported to be related with high light intensity (sun burn) which causes cracking of bark and thus helping infection by various pathogens. Partial shade at the early stage of growth may be helpful to minimise incidence of this disease.

Minor diseases

Citrus scab, sooty mold and melanose attack almost all citrus trees throughout the year. Besides there is greening in all citrus reportedly caused by a mycoplasma like organism which needs further study. This study will be continued in these research stations as well as in other citrus growing areas.

Experiment No. 11

(1) Title: Studies on the effectiveness of Bordeaux mixture (4:4:50) in controlling canker disease of citrus.

Researcher: Ashraf Khan, and A.M. Abdullah

Objective: To determine the efficacy of spraying Bordeaux mixture (4:4:50) in the control of canker disease of different citrus species.

Materials and Methods:

Lime and lemon were found to be more susceptible to this disease in a previous study. So, this trial was taken up to control canker in Rangpur lime, Elachi lebu, Seedless lemon and Kagzi lebu with the easily available freshly prepared Bordeaux mixture (4:4:50). It was conducted at the Jaintiapur Research Sub-Centre. Five plants of each variety was sprayed with the chemical in the first week of every month during October, 1980 to April, 1981. There were five untreated control plants of each variety. Percent infection was determined by visual observation.

Results and Discussion:

The result with respect to percent infection of canker is shown in Table 1. The spray was found to be effective to minimise canker infection to a great extent.

Table 1. Percent canker infection on lime and lemon varieties treated with Bordeaux mixture (4:4:50)

	Nov.	Dec.	Jan.	Feb.	Mar.	April	Mean
Rangpur lime							
Treated Plants*	33.7	28.2	14.9	21.1	7.5	8.6	18.7
Control	23.8	46.7	20.3	20.0	25.4	10.1	24.4
Elachi lebu							
Treated plants*	23.2	19.7	16.2	11.4	17.0	19.5	17.6
Control	25.9	26.0	20.9	21.0	47.5	20.5	26.9
Seedless lemon							
Treated plants*	21.9	25.2	20.2	28.5	10.8	6.1	18.0
Control	43.8	38.1	29.0	29.3	19.4	18.1	29.6
Kagzi lebu							
Treated plants*	32.7	24.6	20.7	10.2	8.1	13.9	18.4
Control	30.3	50.0	25.4	9.5	21.1	13.3	24.9

* Mean of 5 plants

Experiment No. 12

(1) Title: Studies on the incidence and seasonal abundance of different pests in promising citrus varieties.

Researcher: Shahana Begum, and A. M. Abdullah

Introduction:

Mandarin orange is grown to some extent in the district of Sylhet and Chittagong hill tracts while lime, lemon and pummelo are grown throughout the country mostly in homesteads. There are some commercial orchards of lime, lemon and pummelo in the district of Sylhet, Chittagong hill tracts and Pabuna. However, the climatic condition of Bangladesh is not very suitable for the cultivation of sweet oranges.

The citrus plants at all growth stages are attacked by a number of insect pests and suffer considerable losses. The reduction of their losses along can boost up citrus production even with the existing area in plantation in the country. With this view

this survey work has been taken up with the Citrus and Vegetable Seed Research Centre, BARI.

Materials and Methods:

All insects species listed in this paper were collected from 116 different citrus varieties cultivated in the field of Citrus and Vegetable Seed Research Centre, Joydebpur. The survey was carried out for three years from 1979 to 1982. The insects were collected in their larval, pupae and adult stage simply by hand and hand-net. When the insects were collected in the larval and pupae stage they were reared in the laboratory from which ultimately emerge out the adult. Adult insects were pinned up or preserved in alcohol as and when necessary. The insects were then identified in the laboratory. According to their population density and percentage of infestation the insects were graded to as major and minor. These were also divided into 3 groups, such as leaf feeders, sap-suckers, and borers according to their feeding habits.

Results and Discussion:

Twenty three different species of insects feed on different parts of citrus plants. Four species were considered as major in Joydebpur and others were of minor importance. Alam (1974) listed 19 species of insect pest attacking different groups of citrus throughout Bangladesh. The present study however adds another eight new species of pests, attacking citrus in Joydebpur. These are Chillades lajus Stoll, Psorostica zisyphi Station, Mylocerus discolor Scheman, Chrysomphalus aonidum L. Saisetia coffeae (Walker), Parlatoria cleae Colvee, Atherigona orientalis Schiner, and Chloropulvinaria (Cockerell). Orange tree borer (Phynchoris humeralis Th) and orange fruit fly (Chaetodacus sp.) were listed and described by Alam (1974) but not found during this survey.

Leaf-feeders

The leaf miner, Phyllocnistis citrella belongs to the family Phyllocnistidae. The adult insect is a tiny greyish moth measuring about 2 mm in length. The cream coloured larvae after hatching mines into the leaf tissue just under the epidermis. The life cycle completed in about 14-32 days.

The affected plant can easily be recognised by the peculiar transparent shiny irregular mines and curling nature of the leaf.

The citrus leaf miner is a major pest because of its damaging habit. In severe cases percentage of infestation may be up to 55. Investigation revealed that the leaf-miner infests the plant throughout the whole year while the population increases from August to October.

Only the young tender leaves are attacked by the insects and young plants are much susceptible to this insect. Citrus leaf miner help bacterial dissemination and infestation (Kurisaki, 1920 and Hayes, 1957). The infestation predisposes the plant to the attack of citrus canker.

The lemon butterfly (Papilio demoleus, Papilio polytes) is another most important pest of citrus in Bangladesh. Two species of this insect Papilio plotytea, Papilio demoleus were found to infest different variety of citrus. According to Alam (1974) and Fletcher (1917) Papilio demoleus and Papilio polytes are responsible for the damage of citrus.

The population of Papilio polytes is however found to be lower than that of Papilio demoleus. The infestation ranges from 40-60, percent.

Papilio demoleus L. belongs to the family papilionidae. The adult insect is a beautiful black coloured butterfly with yellowish spots on the wings. The pale yellow coloured eggs are laid singly on the leaves. The young caterpillar is dark brown with white streaks on the body, while the full grown caterpillar is green. The larval stage varies from 8-12 days and the pupae period last for 17-24 days depending upon the temperature one life cycle completes in about 30-38 days depending upon the temperature.

The caterpillar is a voracious feeder of tender leaves of citrus. They feed sometimes even on the mature leaves. Generally they eat leaf-edges at first and then proceed towards the midrib. Throughout the larval period they feed on leaf and finish the whole leaf blade leaving only the midrib.

The number of caterpillar were maximum in February and after if the population again decreased gradually with the larval counts reaching their minimum in May, 1981.

Chillades lajus Stoll. is a newly recorded occasional pest. It was found to be serious during the year 1980-81 when the percentage of infestation was about 50%. It belongs to the family Lycaenidae. Bingham (1907) has also recorded its infestation in citrus plants.

The adult insect is a small butterfly having metallic bluish violet colour on the upperside and mottled gray colour on the underside. The larval

are green coloured and young pupae at maturity becomes brown.

The larval feed only on very tender leaves. The larval feed on the balds and scraps upon the chlorophyll of the leaves also makin some what net like structure. So the infested leaf shows the characteristic stripped off leaves and net-like structure at a time.

Sap-suckers

The sap-suckers attain the second place among the three groups of citrus infesting insects. Among the sap-suckers scale insect, psyllid, aphids and black fly were important ones. In this group Florida red scale was found to be very serious pests Florida red scale (Chrysomphalus aonidum) is a major pest. The scale of this insect is dark brown or almost black. The young larval, the early stage to male and the female suck sap from the leaves, fruits and in some cases tender shoots.

The infestation of Florida red scale is recognized by the presence of scale insects itself and the yellowish spots of the infested leaves. As a results of infestation the growth of the plant is retarded, the plant is weakned and defoliated, and in severe cases the plant may even die. The percentage of infestation ranges from 10 to 100. The population of this insect was recorded to be maximum in October.

The egg and the crawler are lemon-yellow in colour and very small in size, respectively. The adult female was ovoid in shape without wing and legs. The adult male was however a light orange coloured two winged insect. The duration of first instar nymph varied from 9.3 to 24 days with an average of 15.64 days. There was no difference between male and female until first moult completed. The duration of second instar female variad from 8 days to 16 days with an average of 11.48 days. The total period for the development of egg to adult female varied from 18.5 to 40 days with an average of 27.28 days. The prepupae stage was reached after 8-16 days with an average of 11.48 days. The male emerged always after 2 or 4 days after the female has become adult.

The psyllid (Diaphorina citri) is commonly known as lemon leaf hopper, and is an occasional pest of citrus.

The adult is greyish with brown coloured bands in the wings. The crawlers are orange coloured and slow moving insects. Both the adult and the crawler suck sap from the leaves and tender parts of the citrus plants.

The activity of the citrus aphids (Toxoptera citricidus) is high in December-January and gradually lowered in summer months but a sudden build

up was noticed in August and September. As a result of its attack, the young leaf flush curls up, and sometimes the leaf drops. According to Wallace (1967) T. citricidus is an efficient vector of tristesa virus.

Borers:

The borer infestation was not found to be of major concern. Among the borers the shoot borer (Arbela tetraonis M.) belonging to the family Arbelidae and the fly (Atherigona orientalis) belonging to the family muscidae were recorded and studied.

The adult shoot borer (Arbela telereonis M.) is a short stout built pale brown moth with rows of dark red spots on the fore-wings. The larval is dirty pale brown with dark head that bores and feeds on tissues within the young shoot and stems.

Fruit-fly was however not found to infest the fruit of citrus in Joydebpur in the year of 1979-82. Atherigona orientalis was however bred in the laboratory.

The adult Atherigona fly is slightly smaller than the common house fly with clear transparent wings. The abdomen is brown and head is greyish. The eggs are laid under the skin of the fruit. The legless maggot hatches from the egg. The white coloured maggot bores into the fruit. The infested fruit rots and drops to the ground. Pupation takes place within the fruits.

Besides these main problems of leaf-eater, borer and sap-sucker there are many pests occurring on the citrus plants. These are leaf-roller, mealy scale, mealy bug, weevil, leaf-hopper, and tree-hopper etc.

Table 1 List of citrus pest (major)

Common name	Scientific name	Population density/100 leaves(maximum)	Occasion
Citrus leaf miner	<u>Phyllocnistis citrella</u> Stainton (leaf caters)	35.18	October
Lemon butterfly	<u>Papilio demoleus</u> L. (leaf caters)	0.86	February
Butterfly	<u>Chillades lajus</u> Stoll. (leaf caters)	0.83	August
Florida red scale	<u>Chrysomphalus aonidium</u> L. (sap-sucker)	1358.65	October

Table 1 List of citrus pest (major)

Common name	Scientific name	Population density/100 leaves(maximum)	Occasion
Lemon butterfly	<i>Papilio polytes</i> L. (leaf eater)	Not studied	-
Citrus leaf-roller	<i>Psorostica zisyphi</i> Station (leaf eater)	"	-
Weevil	<i>Myloccerus discolor</i> Scheman (leaf eater)	"	-
Bettle	Unidentified(leaf eater)	"	-
California red scale	<i>Aonidiella aurantii</i> M. (sap-sucker)	"	-
Citrus yellow scale	<i>Aonidiella citrina</i> Coquillet (Sap-sucker)	"	-
Citrus aphids	<i>Toxoptera citricidus</i> Kirkaldy (sap-sucker)	"	-
Psyllid	<i>Diaphorina citri</i> Kuwayama (sap-sucker)	"	-
Black fly	<i>Aleurocanthus woglumi</i> Ashby (sap-sucker)	"	-
	<i>Aleurocanthus spiniferus</i> Quaintance (sap-sucker)	"	-
Long tailed mealy bug	<i>Ferrisia virgata</i> Cockerell (sap-sucker)	"	-
Citrus mealy bug	<i>Pseudococcus</i> sp. (sap-sucker)	"	-
Citrus mealy scale	<i>Chloropulvunaria pelygonsta</i> Cockerell (sap-sucker)	"	-
Olive-scale	<i>Parlatoria oleaae</i> Colvee (sap-sucker)	"	-
Hemispherical scale	<i>Saissetia coffeae</i> Walker (sap-sucker)	"	-
Tree hopper	<i>Otinotus elongatus</i> Dist. (sap-sucker)	"	-
Citrus flower thrips	<i>Frankliniella</i> sp. (sap-sucker)	"	-
Shoot borer	<i>Arbela tetraonis</i> M. (Borer)	"	-
Fruit borer	<i>Atherigona orientalis</i> Schiner (borer)	"	-

Experiment No. 13

(1) Title: Studies on the biology and seasonal abundance of Florida red scale insect (Chrysomphalus aonidum L.: Coccidae, Homoptera) in lemon and oranges

Researcher: Shahana Begum, and A. M. Abdullah

Objective: To study cycle of the Florida red scale insect. Its parasites and predators and nature and extent of damage caused by it on lemon and oranges.

Materials and Methods:

This study was carried out at the Joydebpur Research Station both in the field as well as in the laboratory during June, 1979 to June, 1980. Insect population was maintained in a number of potted citrus plants by adding newly hatched crawlers in batches.

Results and Discussion:

The eggs were lemon-yellow in colour, oval in shape, and measuring 0.7 mm and .043 mm in length and breadth respectively. The incubation period was 24 hrs. Average percentage of hatching was almost 98.02% during the month of August and September. Upon settling the development of the first instar the nymph started. The first instar nymph moulted in 9-12 days with an average of 10.9 day in the month of August and September. There was no difference between male and female until first molt and at 14th or 15th day the red brown male became elongated and spindle shaped and eyes become visible. The male passed through prepupae, and pupae stage and then emerged as adult. The total period for the development from egg to adult male was on an average 23 days. The period from the completion of 2nd moult to the first egg deposition was 38 to 45 days. While the deposition period varied from 4 to 7 weeks.

Regarding the behaviour, it can be noted that the crawler spent some time under the mother scale. They moved restlessly until they got a suitable place to settle. Except for few cases more than 60% of male scale were found on the dorsal side of the leaf while most female were found on the ventral side of the leaf. July to September was the peak period of infestation and maxi-

mum adult population was found in the field at that time. The population of the insect rapidly falls down in winter months. Until now Menochilus sexmacalatus has been recorded as one of the predator of Chrysomphalus aonidum L.

Experiment No. 14

(1) Title: Studies on the population and fluctuation of a leaf hopper.

Researcher: Abdul Mannan, and A. M. Abdullah.

Objective: To findout population density of the lemon leaf hopper in different season

Materials and Methods:

1. Five plants to be selected
2. Fifty percent leaves to be selected at random from different branches per plant
3. Insect population to be counted in nymphal stage
4. Data on population to be counted in every 15 days. Nymph of the insect to be collected and then counted
5. After every one month, the total number of insects attached the plants to be counted and in this way dates to be taken through the whole year.

Observation:

1. Number of selected branch per plant
2. Number of leaves per branch
3. Number of infested leaves per branch
4. Number of nymph in infested leaves.

Result and Discussion:

Now the trials and observation are continueing.

Experiment No. 15

(1) Title: Studies on the effectiveness of insecticides for the control of lemon butterfly on seedless lemon.

Researcher: A. M. Abdullah, M. J. Islam, H. Nagai, and H. Daito

Objective: To find out the most effective insecticides for the control of lemon butterfly on seedless lemon.

Materials and Methods:

Number of replication: 3

Number of plant per unit plot: 3

Number of treatments: 8

Insecticides

- A. Nogos 100 Ec
- B. Diazinon 60 Ec
- C. Perfecthion 40 Ec
- D. Lebaycid 50 Ec
- E. Metasystex 25 Ec
- F. Zithiol 57 Ec
- G. Malathion 57 Ec
- H. Control

When insects attack lemon trees, then first spraying to be start and it will be continue by spraying insecticides in every 21 days after intervals. Control plot to be spray with water only care should be taken in such a way that no insecticides fallen control plot and during spraying any treatment in any plot, then the plot fences with gunny cloth, so that during spraying this insecticides not fall on another plot. Spraying insecticides in such a way that it fall on leaves just as a dot, not fall as rain water, select the less height plant for this experiment. It should known that larval stage of the butterfly damage the lemon leaves.

Data to be taken just before the spraying date.

Observation:

1. Number of total leaves per plant
2. Number of attacked leaves per plant

Results and Discussion:

Now the trials and observation were continueing.

Appendix - I

Summarised weather report for 1981
Main Centre, Joydebpur, Dhaka

Weather variables	January	February	March	April	May	June	July	August	September	October	November	December	Monthly Average
Air temperature in °C (Monthly mean)													
Max.	25.8	27.2	30.89	31.54	32.1	32.6	31.2	32.4	31.9	33.5	30.1	25.9	30.43
Min.	14.6	16.0	15.51	20.34	25.5	27.2	26.7	26.6	26.0	23.8	18.6	15.6	21.62
Soil temperature in °C (Monthly mean)													
Max.	22.4	24.3	26.95	28.37	29.0	30.4	28.8	30.1	30.0	31.1	27.3	23.56	27.69
Min.	21.9	22.5	25.08	25.87	27.7	29.1	28.2	28.9	29.3	25.8	22.3	22.3	26.29
Relative humidity in% (Monthly mean)													
Max.	92.0	89.9	86.56	87.7	88.1	86.1	85.8	85.4	80.8	83.2	85.8	81.15	86.05
Min.	45.2	41.9	40.63	55.39	59.9	61.1	71.9	65.4	60.6	40.0	35.8	37.1	51.24
Precipitation (Monthly total in mm)													
No. of rainy day	2	5	10	14	12	12	18	22	13	1	1	2	112
Precipitation in mm	3.3	51.3	61.2	341.7	203.5	150.3	307.5	434.0	190.7	14	10	26.7	1794.2
Solar radiation in cal/cm ² (Monthly total)													
Integrator I (top of the roof)	8482	9047	10790	12149	12398	12234	8874	12556	8954	10678	7969	7667	121798
Integrator (Bush)	2810	2040	2771	5224	5801	5537	4394	4032	3141	4304	2303	2975	45332

Note: Country of Meteorological Services Section, CVSRC, BARI.

Latitude 24°-0'-0"N
Longitude 92°-25'-0"E

Appendix - II

Summarised weather report for 1982
Main Centre, Joydebpur, Dhaka

Weather variables	January	February	March	April	May	June	July	August	September	October	November	December	Monthly Average
Air temperature in °C (Monthly mean)													
Max.	27.5	27.9	31.7	34.0	35.56	32.23	33.16	31.91	33.36	33.3	28.4	26.93	31.33
Min.	14.5	16.2	21.4	23.9	26.1	26.95	27.45	27.17	26.81	24.12	18.31	14.82	22.31
Soil temperature in °C (Monthly mean)													
Max.	24.7	26.0	28.5	29.8	30.93	29.57	30.42	29.99	31.13	31.57	33.01	25.22	29.14
Min.	23.4	24.4	24.7	28.4	29.8	28.57	29.70	28.67	29.72	29.33	29.96	23.35	27.5
Relative humidity in% (Monthly mean)													
9 A.M.	83	63.1	69.3	75.0	75.0	76.2	86.16	85.84	82.21	73.0	70.17	76.39	77.26
12 Noon				68.6	70.2	81.62	80.05	74.26	74.29	67.42	66.29	61.18	71.55
4 P.M.				69.4	68.64	81.69	79.60	79.84	74.26	65.28	61.29	61.29	72.19
Precipitation (Monthly total in mm)													
No. of rainy days	-	-	5	12	10	13	14	14	10	2	2	-	84
Precipitation in mm	-	7.0	160.0	222.0	194.1	515.6	153.3	275.1	150.9	31.0	28.4	-	1737.4
Solar radiation in cal/cm ² (Monthly total)													
Integrator I (top of the roof)	84.73	8354	11165	13113	17036	9301	11676	12028	10315	10870	7641	7438	127414
Integrator (Bush)	2209	2389	4201	5556	7721	3736	4669	4313	4338	4306	2582	2649	48669

Note: Country of Meteorological Services Section, CVSRC, BARI.

Latitude 24°-0'-0"N
Longitude 92°-25'-0"E

