

**PART 3**  
**AGRO-CLIMATOLOGICAL REVIEW**  
**ON THE DIAMETRICAL DIFFERENCE OF VEGETATION**  
**BETWEEN DRY AND RAINY SEASONS OF BANGLADESH**

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## CHAPTER 1 INTRODUCTION

Throughout the results obtained in the series of vegetable trials reported in Part 2, a common diametrical difference of vegetation (plant growth) can be seen in different seasons, that is, in a short, the dry season be a paradise while the rainy season be a hell of vegetable cultivation in Bangladesh. Only very limited kinds of vegetables can be economically grown during the rainy season, that is, all those recommendable vegetables belong merely to tropical and subtropical sorts, but even with such S–E Asian tropical sorts of vegetables, in fact, they grow generally better in October to December than June to August except some limited kinds like Kangkong.

The expert concluded intuitively that the biggest factor affected on this diametrical difference of plant growth is the climatic condition, and he arranged an agro-climatological design of four seasons as described at the head of Tables in Part 1 by his intuitive learnts during his two year stay in Bangladesh. Now, it is the time the expert has to confirm his hypothetical design through a discussion of the actual data of meteorological statistics.

Part 3 is the discussion in this respect by fortunate gotten of a recent 10 years comprehensive meteorological data of Bangladesh at the last period of his stay as well as other corresponding data in other related countries after his come back to Japan. Fortunately his hypothetical design has been completely cleared to be correct, therefore, the expert can publish this report with full of his confidence and he hopes this report could be a marvellous reference to establish a general way to find out a correct adaptation of crops into the places for the development of vegetable horticulture in Bangladesh as well as other countries having similar agro-climatic condition in the tropics and subtropics. At the same time, the expert would like sincerely to receive comments on this discussion from the readers.

**Acknowledgement:** The expert would like to express his thanks to Mr. Mofazzal Hossain of CERDI, Bangladesh for his kind collection of the meteorological data of Bangladesh from the Governmental authorities and Dr. Eizo Maruyama of Japan Meteorological Agency for his kind offer of comprehensive meteorological data of concerned countries as well as adequate advices concerned.

## CHAPTER 2 ARRANGEMENT OF CLIMATE GRAPHS AND TABLES

At first all the meteorological data of Bangladesh were converted into international CGS units, that is, the temperature from Fahrenheit to Centigrade and the precipitation from inch to mm, then arranged the data of several representative places into graphic Figures and those of wider ranges into Tables.

### 1. CLIMATOLOGICAL GRAPHIC FIGURES

#### (1) General Remarks

A. Monthly average data of daily maximum and minimum of temperature and humidity were figured with curves and their ranges were expressed by vertical and horizontal parallels respectively while those of monthly amount of precipitation were expressed with bar graphs as seen in the Figures. At this time, the level of temperature and precipitation was coincided as 10°C with 100 mm, 20°C with 200 mm and so forth which is a method to be roughly understood that when the level of precipitation comes to be upper than the temperature it means wet and lower than temperature it means dry, and this tendency is the more remarkable at the higher temperature level.

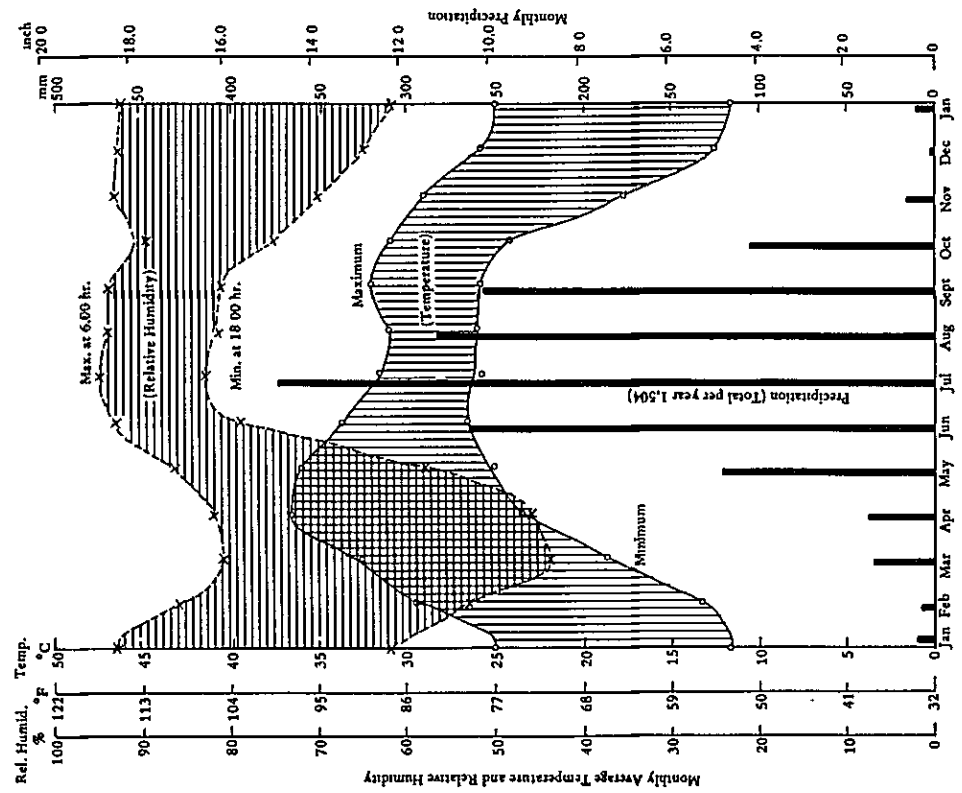
B. About the data of humidity, actually the statistics had been arranged averaging the data taken at the fixed times which are shown on the curves, therefore, although those data are expressed as the maximum and minimum, they are not always showing precisely the average data of daily minimum and maximum humidity values but show the minimum and maximum data among those at the 4 fixed time data, for example, with the data of Bangladesh, minimum means the humidity at 18.00 hour or 6.00 pm and the maximum is at 6.00 hour or 6.00 am. therefore, the minimum data seem to be somewhat higher than those of daily absolute minimum which may appear around 1.00 – 3.00 pm. Despite of the above mentioned, those data show quite enough the change of humidity in a day as a whole as seen in the Figures in comparison with those of other related countries.

#### (2) Remarks on the Selection of Places for Examination

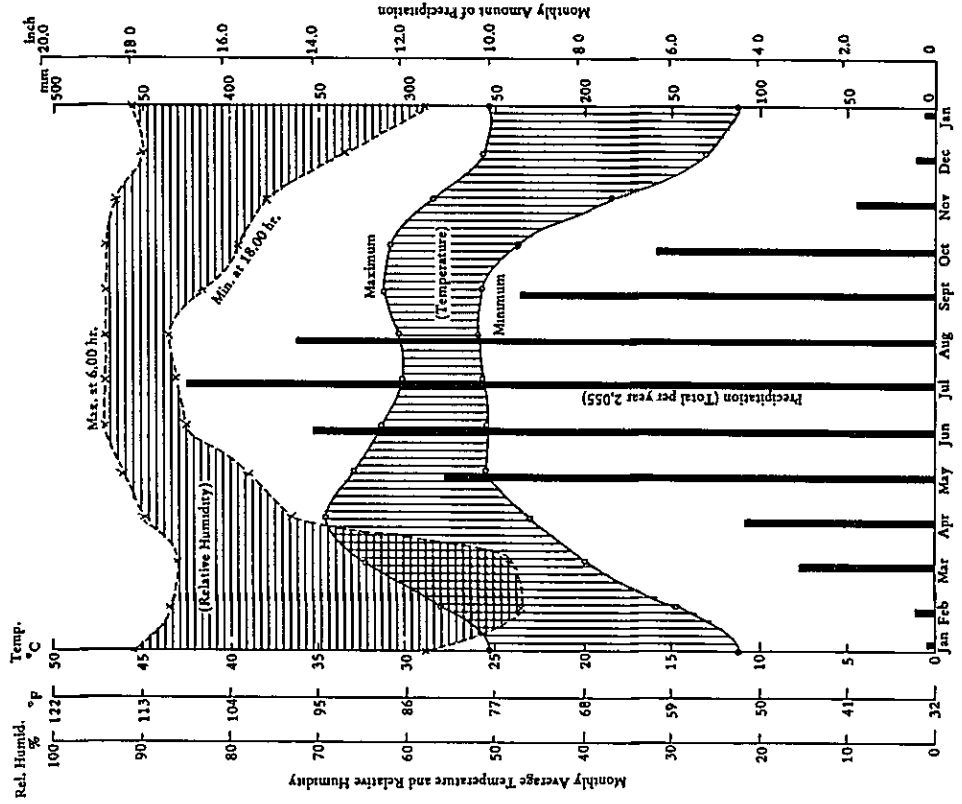
A. Actually those Figures have been prepared at several other places in Bangladesh as well as other countries but eventually offered here only those of 4 Bangladesh cities and 6 representative places in the concerned countries as representing other places. For example, Dacca is representing the central Bangladesh since those of Comilla, Mymensingh are almost the same as Dacca, Rajshahi is representing the west part including Dinajpur, Ishurdi and Jossore since the shape of curves are more or less the same, and Chittagong is representing the western part, Maijidi, Cox's Basar and Rangamati, and Sylhet as a special rainy place.

B. Nagoya is taken as representing an example of Japan's climate or temperate zone, Taichung is taken as an example of the same latitudal place of Dacca in Taiwan or the subtropics, Manila and Bangkok are taken as the higher latitudal tropics nearly at 15°N, and Kuala Lumpur is taken as lower latitudal place near the equator. Moreover, all those places are closely related to the places where the vegetable varieties tested in the trial in Part 2 were introduced and cultivated, that is, their native lands. And Dier Alla, Jordan Valley is taken as an example of desert countries.

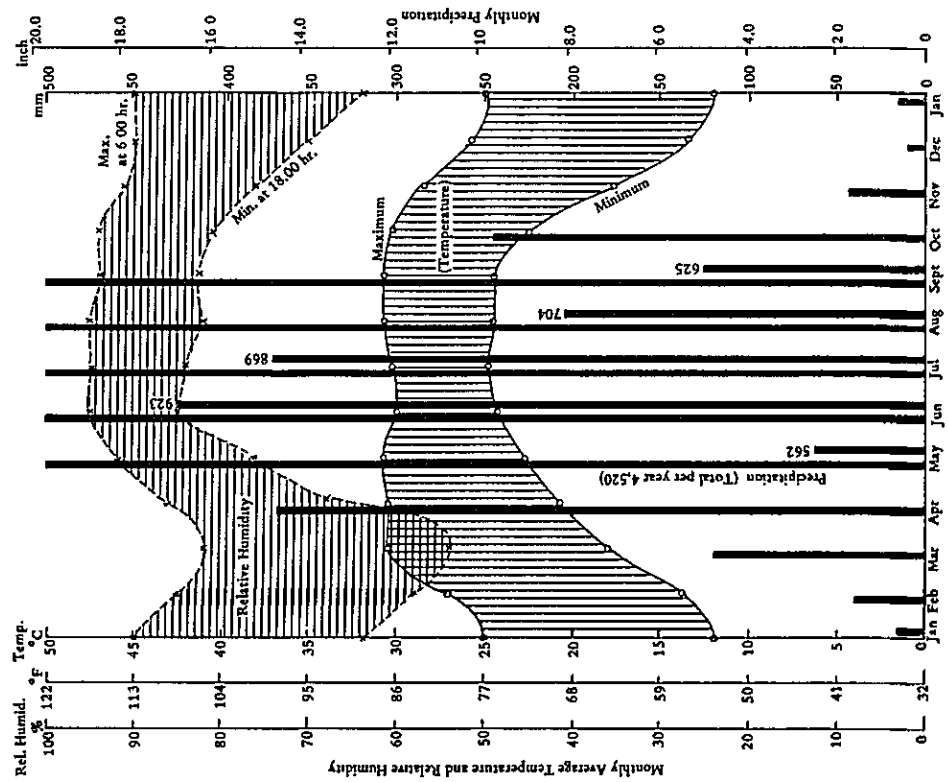
**Fig. 2 Climate of RAJSHAHI, Approx. 24°20'N, 88°40'E**  
 North West Part of Bangladesh  
 Data 1967-76



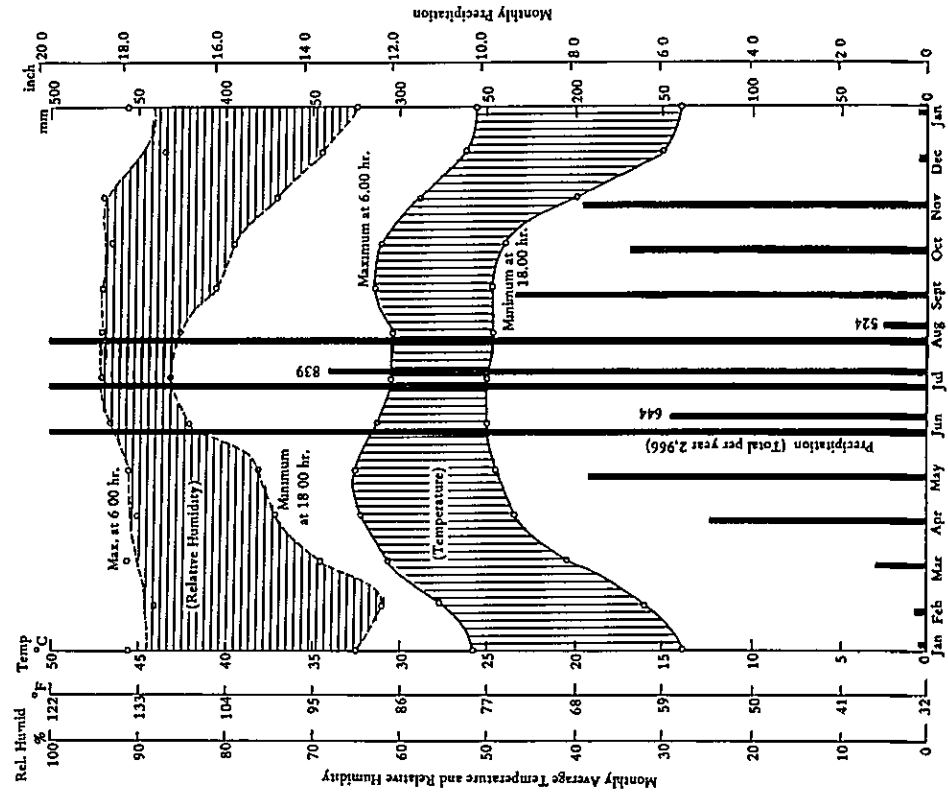
**Fig. 1 Climate of DACCA, Approx. 23°50'N, 90°20'E**  
 Central Part of Bangladesh  
 Data 1967-76



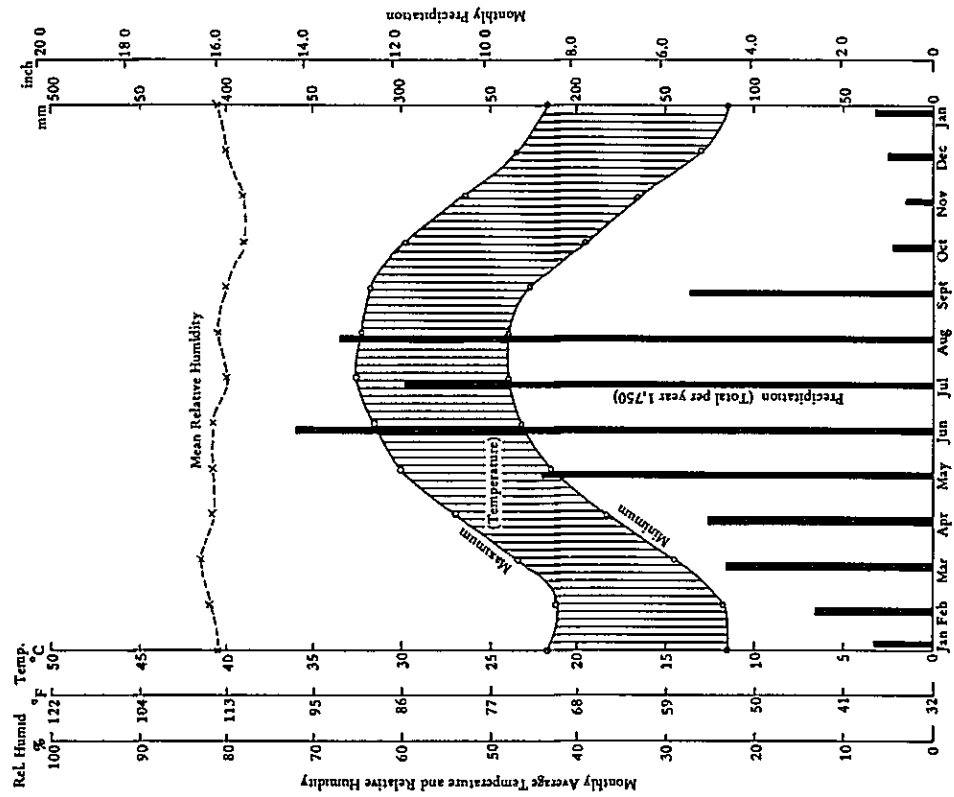
**Fig. 4 Climate of SYLHET, Approx. 24° 55'N, 91° 50'E**  
 North Eastern Corner of Bangladesh  
 Data 1967-76



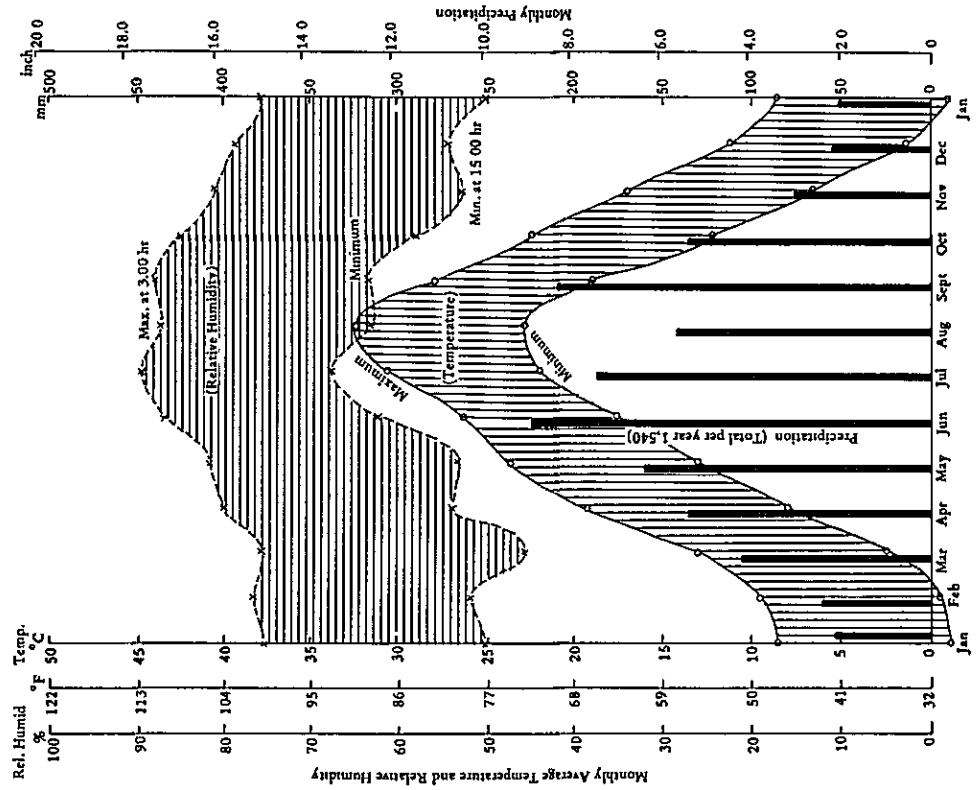
**Fig. 3 Climate of CHITTAGONG, 22° 16'N, 91° 49'E**  
 South East Corner of Bangladesh  
 Data 1967-76



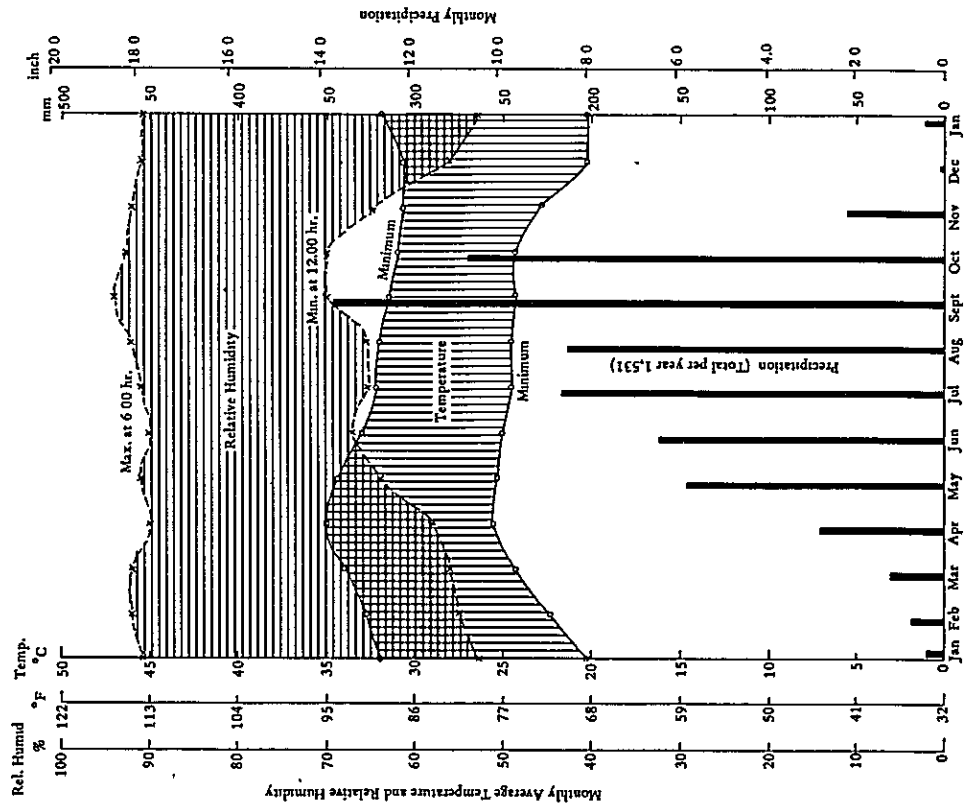
**Fig. 6 Climate of TAICHUNG, 24°09'N, 120°41'E, 78m.AL.**  
 Central Part of Taiwan  
 Data of 1897-1940



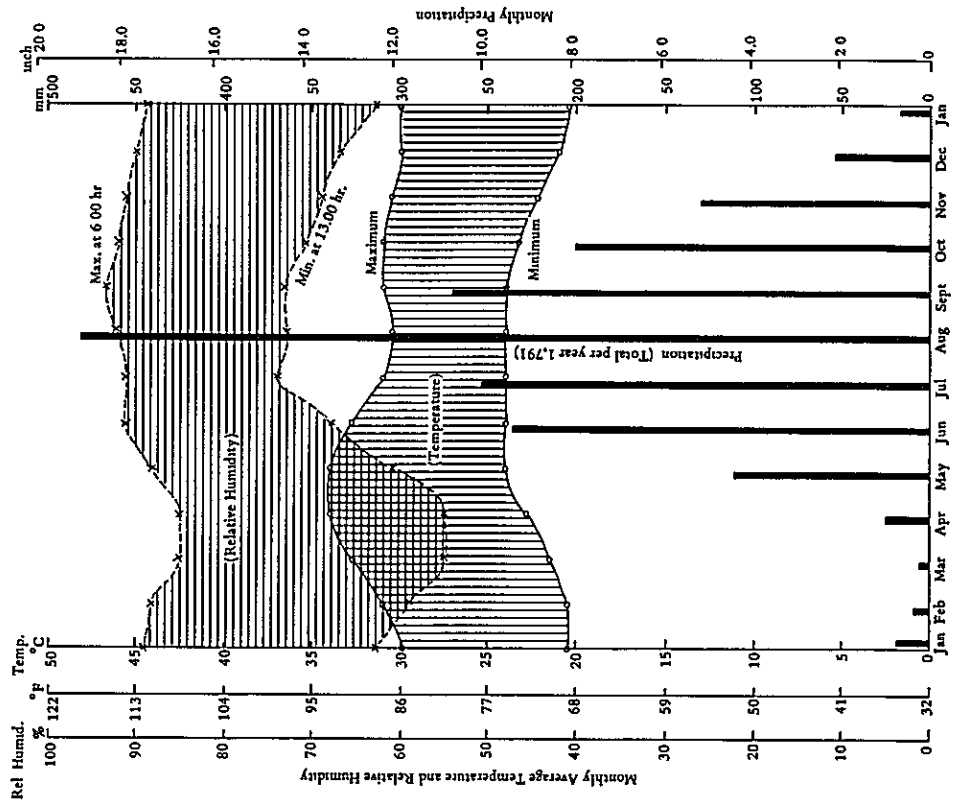
**Fig. 5 Climate of NAGOYA, 35°10'N, 136°58'E, 51m.AL.**  
 Central Part of Main Island, Japan  
 Data of 1941-1970  
 Only R. Humidity 1967-76



**Fig. 8 Climate of BANGKOK, 13°44'N, 100°30'E, 16m.AL.**  
 Central Part of Thailand  
 Data of 1951-60

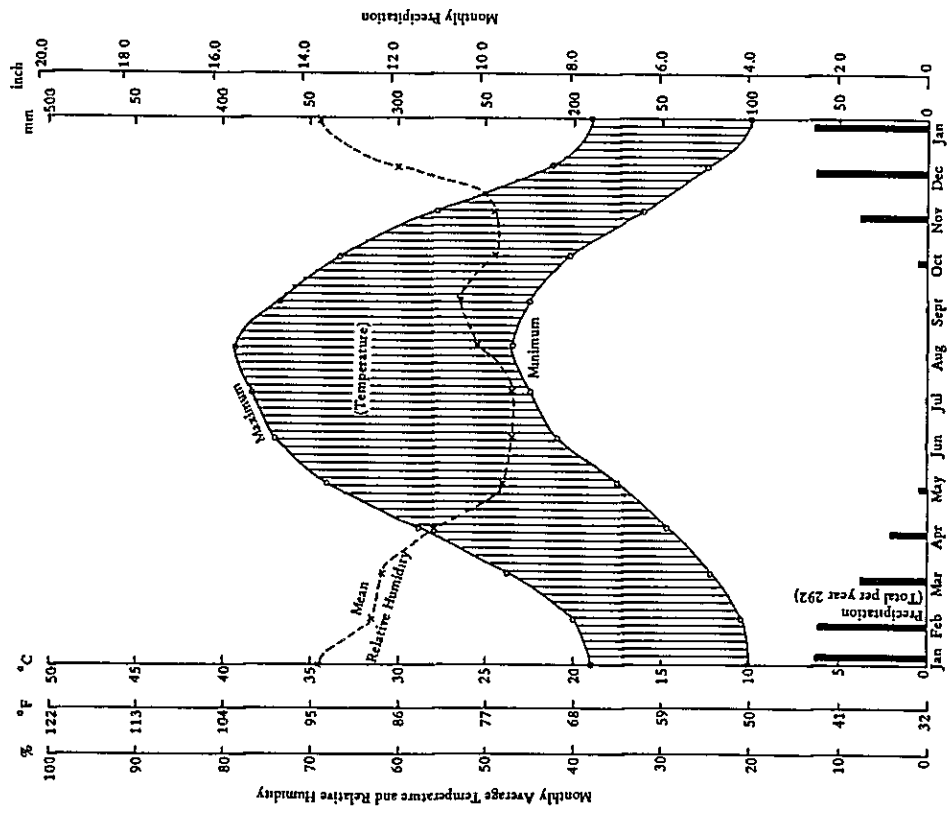


**Fig. 7 Climate of MANILA, Air Port, 14°31'N, 121°00', 15m.AL.**  
 South West Part of Luzon, Philippines  
 Data of 1885-45

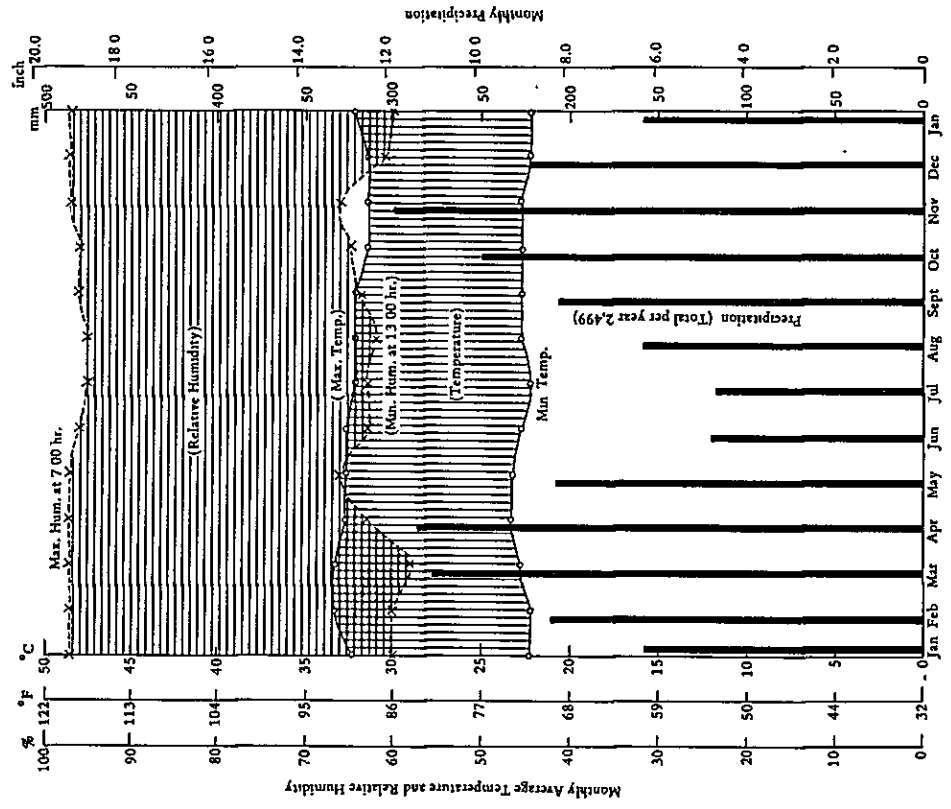




**Fig. 10** Climate of DEIR ALLA, 32°12'N, 35°37'E, -224m.A.L.  
 Central Part of Jordan Valley  
 Data of 1923-65



**Fig. 9** Climate of KUALA LUMPUR, 3°07'N, 101°42'E, 39m.A.L.  
 Central Part of Peninsula Malaysia  
 Data 1930-54



## 2. METEOROLOGICAL DATA TABLES

In order to cover wider range of places concerned and to show actual figures of the data, two meteorological Tables are prepared here, Table 1 is on those of Bangladesh and Table 2 is on the concerned places in other countries.

### (1) General Remarks

A. Examining the characteristics of graphs of Figs. 1 to 10, it has been concluded that the characteristics of change of humidity is deeply related with the change of temperature and precipitation as explained precisely in the next Chapter. Accordingly, the data of humidity has been omitted from the Tables in order to simplify the data and easier to read, because it seems to be enough only with the 10 Figs. to examine general point of climate precisely including factor of humidity.

B. Since the grade of range between maximum and minimum temperatures is a very important factor to diagnose the plant growth response, the data of temperature are expressed by the maximum temperature and the difference but omitted the minimum which can be easily calculated by reduction of the above two figures, the formers are arranged in the upper line and the latter in the lower.

C. The data of Bangladesh was taken from the Meteorological data for average of 1967 - 76 from A. Dep. on 2/4-7-77, which involved 20 places in Bangladesh.

The data of other countries were extracted from the meteorological data books described in the reference list attached.

Table 1 Meteorological Table of Various Places in Bangladesh

#### A. Monthly Amount of Precipitation (mm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Season	Dry Season		1st Cyclonic Sea.			Dense Rainy Sea.			2nd Cyclonic Sea.	Dry Sea.		—	
Mymensingh	24	6	62	112	228	388	499	260	260	150	10	6	1,999
Dacca	4	11	76	107	178	352	424	362	232	157	43	9	2,055
Comilla	4	13	51	152	274	529	380	327	208	157	53	8	2,156
Dinajpur	13	2	50	75	191	180	451	244	45	92	9	0	1,352
Rajshahi	10	8	33	37	121	262	372	282	255	105	17	2	1,504
Ishurdi	13	10	39	83	166	316	311	368	289	153	21	7	1,776
Jossore	13	9	42	67	135	263	379	305	314	152	20	11	1,710
Khulna	2	25	61	77	216	346	542	349	457	177	22	12	2,288
Sylhet	16	39	118	368	562	923	869	704	625	246	42	8	4,520
Majjidi	6	27	91	133	282	660	755	820	384	203	57	0	3,418
Chittagong	4	6	29	122	193	644	839	524	236	171	193	5	2,966
Rangamachi	5	11	25	96	224	645	717	458	222	128	77	2	2,610

**B. Monthly Average of Daily Maximum Temperature (upper) and Its Difference to the Minimum (lower) (°C)**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Season	Dry season			1st Cyclonic Sea.			Dense Rainy Sea.			2nd Cyclonic Sea.		Dry Sea.
Mymensingh	24.7	26.9	31.0	32.8	32.1	31.0	31.0	31.4	31.2	30.9	28.2	25.8
	12.6	13.3	12.8	10.7	8.6	6.1	5.1	5.6	5.6	7.1	10.1	12.1
Dacca	25.2	28.1	32.3	34.4	32.8	31.5	30.3	30.6	31.3	30.8	28.6	25.8
	12.9	13.3	*12.2	11.3	7.2	5.9	4.5	4.6	5.6	7.0	10.2	12.7
Comilla	25.6	28.6	31.9	32.8	32.7	30.9	30.4	30.8	30.9	30.8	29.2	**28.5
	13.4	13.7	12.1	9.7	8.1	6.7	5.0	5.5	5.7	7.0	9.8	*15.2
Dinajpur	24.5	27.2	31.9	35.1	34.1	32.5	32.3	31.8	32.3	31.1	28.7	26.3
	13.9	15.3	12.7	13.7	10.3	7.3	6.1	5.7	7.3	8.7	12.5	14.6
Rajshahi	24.9	28.6	32.6	36.6	35.8	33.7	31.7	31.0	32.1	30.8	29.0	25.8
	13.2	15.3	13.9	13.1	10.9	7.2	5.9	4.9	6.4	6.9	11.2	13.2
Ishurdi	24.7	28.3	32.8	36.4	35.1	33.2	31.7	31.8	31.9	31.1	28.7	25.3
	14.8	16.5	15.5	13.8	10.7	7.9	6.1	6.1	6.5	8.1	11.6	13.5
Jossore	25.4	28.7	33.2	35.4	35.6	33.2	31.3	31.2	31.8	31.4	29.0	26.1
	14.2	15.5	14.0	11.0	10.7	7.6	5.5	5.8	6.2	8.0	11.7	14.7
Khulna	26.9	29.1	33.9	35.4	35.1	32.7	31.6	30.6	32.3	32.6	29.9	26.5
	13.0	12.9	12.7	10.7	9.6	7.6	5.7	4.8	6.3	8.4	9.6	11.9
Sylhet	25.0	26.9	30.5	30.6	30.8	30.1	30.3	30.7	30.7	30.3	28.5	25.8
	13.1	13.1	12.6	9.9	8.1	5.9	5.5	6.1	6.3	7.9	10.7	12.4
Maijdi	25.6	27.9	30.9	32.1	32.1	30.9	30.2	29.4	31.1	30.8	28.6	26.4
	12.4	12.6	11.2	9.4	7.3	5.7	5.1	4.6	5.5	7.1	10.0	13.2
Chittagong	25.7	27.8	30.7	31.9	32.4	31.2	30.6	30.4	31.4	31.0	28.8	26.2
	11.8	11.9	10.3	8.3	7.8	6.1	5.7	5.7	6.6	6.9	8.9	11.2
Rangamachi	26.7	30.1	33.6	34.1	34.3	31.0	30.8	30.8	31.9	31.4	29.1	27.1
	11.1	13.1	12.4	10.8	9.2	5.8	5.6	5.7	6.2	6.6	7.6	9.9

Remarks: \* Original data of Min./Mar. has been 86.2°F but corrected to 68.2°F.  
 \*\* Original data of Max./Dec. has been 63.3°F but seemed to be too low, so, corrected to 83.3°F, however, this converted figure of 28.5 seems to be somewhat higher than expected.

**Table 2 Meteorological Table of Various Concerned Places**

**A. Monthly Amount of Precipitation (mm)**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Nagoya	52	59	104	136	160	226	187	143	209	133	76	56	1,540
Karuzawa	36	42	66	90	126	196	184	184	173	139	55	34	1,324
Taichung	33	64	114	126	221	359	297	336	136	23	16	25	1,750
Manila	18	7	6	24	110	236	253	480	271	201	129	56	1,791
Baguio	12	15	39	105	288	476	577	818	671	257	142	30	3,429
Bangkok	9	18	30	71	145	159	216	212	344	270	56	2	1,531
Pai	44	3	2	83	226	176	182	284	212	40	10	21	1,234
Kuala Lumpur	157	209	277	285	207	121	117	157	206	251	289	223	2,499
Tanah Rata	168	132	216	297	246	140	122	163	259	340	330	229	2,642
Singapore	285	164	154	160	101	127	183	230	102	184	236	306	2,282
Deir Alla	63	59	38	19	6	0	0	0	t	5	38	62	292
Amman	64	67	37	15	4	0	0	0	t	5	30	50	272

**B. Monthly Average of Daily Maximum Temperature (upper) and Its Difference to the Minimum (lower) (°C)**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Nagoya (Japan, L.)	8.5	9.4	13.1	19.2	23.8	26.6	30.7	32.6	28.1	22.4	17.1	11.2
	9.4	10.0	10.9	11.2	10.9	9.0	8.6	9.6	9.0	10.1	10.7	9.6
Karuizawa (Japan, H.)	1.8	2.1	6.1	13.3	18.0	20.9	24.6	26.2	21.0	15.5	11.0	4.4
	11.8	12.3	12.4	13.7	13.0	10.0	8.9	9.6	8.8	11.0	12.3	10.9
Taichung (Taiwan, L)	21.8	21.3	23.5	27.0	30.0	31.5	32.5	32.3	31.7	29.7	26.6	23.4
	10.3	9.3	9.1	8.8	8.5	8.3	8.5	8.4	9.0	10.1	10.3	10.3
Manila (Philippines)	30.0	31.1	32.8	33.9	33.9	32.8	31.1	30.5	31.1	31.1	30.5	30.0
	9.6	10.6	11.2	11.1	10.0	8.9	7.2	6.6	7.2	7.8	8.3	8.9
Baguio (Philip., H)	22.0	22.8	23.6	23.8	24.7	22.2	22.7	20.6	22.7	22.6	22.6	21.8
	9.0	10.3	9.9	8.2	8.5	6.0	6.5	4.3	6.9	7.5	8.0	8.9
Bangkok (Thailand, L)	31.9	32.7	34.0	35.1	34.3	32.9	32.3	32.0	31.6	31.0	30.8	30.8
	11.6	10.2	9.7	9.6	9.1	7.9	7.7	7.6	7.4	6.8	8.0	10.6
Pai (Thailand, S.H.)	29.0	31.2	34.8	37.0	34.2	32.1	31.2	30.6	30.5	30.2	26.8	28.6
	18.5	21.6	22.8	18.9	12.6	9.3	8.9	8.2	8.7	10.3	10.9	17.2
Kuala Lumpur (Malaysia, L)	32.2	33.3	33.3	32.8	32.8	32.8	32.2	32.2	32.2	31.6	31.6	31.6
	10.0	11.1	10.5	9.5	9.5	10.0	10.0	9.4	9.4	8.8	8.8	9.4
Tanah Rata (Malaysia, H)	21.6	22.2	22.8	23.3	23.3	23.3	22.8	22.2	22.2	22.2	21.6	21.6
	8.3	9.4	10.0	9.4	8.9	10.0	10.0	8.9	8.3	8.3	7.7	8.3
Singapore (L.)	30.0	31.1	31.1	31.1	31.6	31.1	31.1	30.5	30.5	30.5	30.5	30.5
	7.2	8.3	7.2	7.2	7.7	7.2	7.2	6.6	6.6	7.2	7.2	7.2
Deir Alla (Jordan, Depress.)	18.9	19.9	23.7	28.7	34.1	37.0	38.3	39.2	36.8	33.3	27.7	21.2
	8.8	9.3	11.5	14.0	16.5	16.1	15.9	15.6	14.4	13.1	11.6	8.6
Amman (Jodan, H.)	12.5	13.7	17.6	22.6	28.0	31.0	32.1	32.8	30.9	27.5	21.0	14.8
	8.8	9.4	11.4	13.3	14.6	14.7	14.0	14.4	14.7	13.8	11.4	9.4

Remarks: L = Lowland, H = Highland, S.H = Semi Highland

**(2) Remarks on the Places Selected in Bangladesh**

Locations of 12 selected places in the Table 1 can be found in the map of Fig. 11. Mymensingh, Dacca and Comilla represent the central area of the country and their precipitations per year are also medium at around 2,000 mm. Dinajpur at the north-west has the least precipitation of about 1,350, Rajshahi, Ishurdi and Jossore represent the west-central having rather less precipitation at 1,500 to 1,700 mm and Khulna at the west-south has medium much precipitation of about 2,300, while the eastern part shows much precipitations such as, the north east corner of Syleht shows the highest as more than 4,500 mm which situates at the foot of Khasi-Jainta Mountains of Assam, Cherrapunji, the famous world highest rainfall area, and Maijidi and Chittagong as well as Cox's Bazar are high precipitation area having 3,000 to 3,500 mm as the east end of Bay of Bengal. Randamach is located in a basin topography of single mountain area in Bangladesh, therefore, having somewhat less precipitation than Chittagong.

**(3) Remarks on the Places Selected in Concerned Countries**

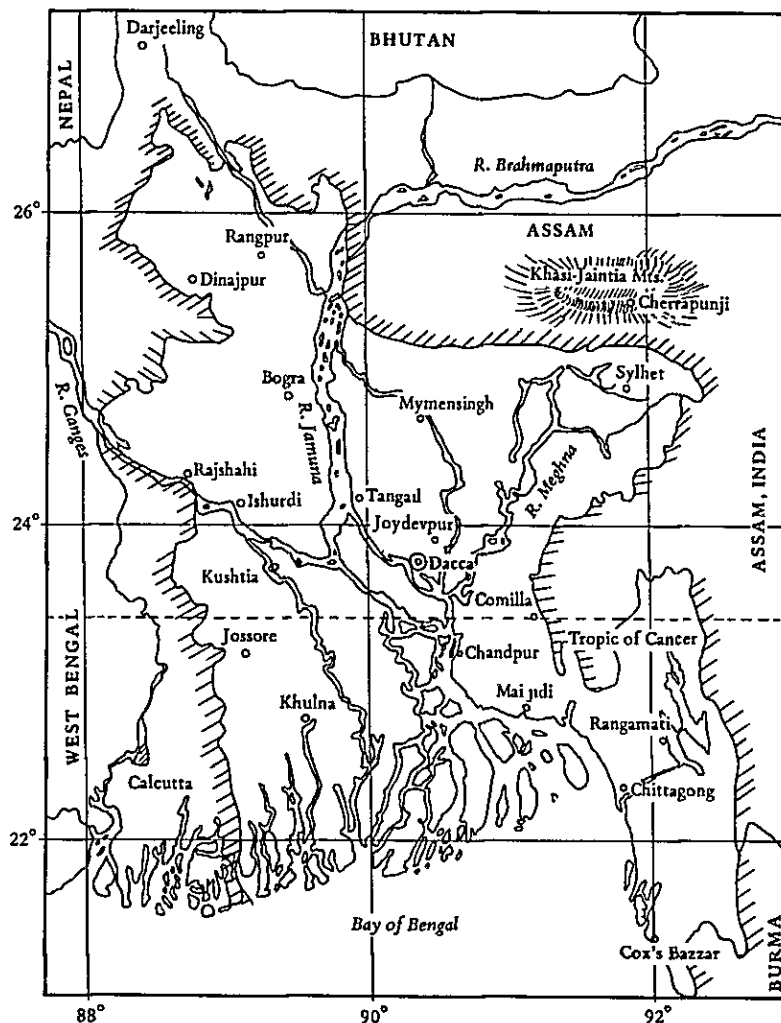
A. Japan: It is selected as a temperate zone area from where most of temperate zone

vegetable varieties tested in the trials had been introduced.

Nagoya ( $35^{\circ}10'N$ ,  $136^{\circ}58'E$ , 51 m, Al.) is selected as the central part of Japan having a medium climatic condition in the country though she has a wide range of climatic diversity from cold to subtropical. Karuizawa ( $36^{\circ}20'N$ ,  $138^{\circ}33'E$ , 99 m Al.) is selected as a representative place of highland in the central Japan belonging to one of the highland summer vegetable production area though actual mid-place is situated about 1,100–1,350 m Al., the climate is more or less similar to Hokkaido and West Europe.

B. Taichung ( $24^{\circ}09'N$ ,  $120^{\circ}41'E$ , 78 m Al.): It is selected as the same latitudal place as Dacca in Taiwan from where many improved varieties of S–E Asian vegetables tested in the trials had been introduced but also due to National Seed Improvement Center of Taiwan which has established many foundation seed stocks of S–E Asian native vegetables is located in Taichung.

Fig. 11. Map of People's Republic of Bangladesh



C. Philippines: It is selected as one of the S-E Asian countries. Manila (14°31'N, 121°00'E, 15 m Al.) is located at the Center of the country and one of the representative cities which have one of the representative suburban vegetable production places in S-E Asian cities. Really Manila has two meteorological stations but the data of Manila Air Port is selected due to closer station to the vegetable production place. Baguio (16°25'N, 120°36'E, 1,500 m Al.) is selected as one of the representative highland vegetable production areas in S-E Asian countries which is located at the entrance of Mountain Province called "Salad Bow" in the Philippines actually ranging 1,500-2,400 m altitudes and its climate is responding to subtropics or north part of Taiwan.

D. Thailand: It is selected of course as the closest concerned country to Bangladesh from where majority of S-E Asian vegetables tested in the trial had been introduced. Bangkok (13°44'N, 100°31'E, 2 m Al.) is selected as the center of Thailand and many research institutes are located at surroundings. Pai (19°20'N, 98°58'E, 539 m Al.) is selected as a semi-highland area situated at the north west corner of Thailand bordering to Shan Highland of Burma and due to Thailand Government is now making effort to develop highland horticulture in this mountainous area replacing with opium culture. Though the altitude is not enough as high as Baguio and Tanah Rata but since its climate has remarkable range of maximum and minimum temperatures, this area could be a promising place to cultivate temperate zone vegetables as discussed in detail in latter Chapter.

E. Malaysia and Singapore: They are selected as advanced countries in the suburban short period vegetable production places in S-E Asia. Kuala Lumpur (3°07'N, 101°42'E, 39 m Al.) and Singapore (1°18'N, 103°50'E, 10 m Al.) are selected as the low latitudal tropics. Tanah Rata (4°28'N, 101°23'E, 1,448 m Al.) in Cameron Highlands situated in the center of West Malaysia is selected as one of the representative highland vegetable production areas in S-E Asian countries together with Mountain Province in Luzon and Kalo Highland in Smatora.

F. Jordan: Hashemite Kingdom of Jordan is selected as one of the desert countries in Arabia to compare its desert climate condition with the dry season of Bangladesh having a wide range of the maximum and minimum temperatures. The climate of Deir Alla (32°12'N, 35°37'E, -224 m Al.) situated at the center of Jordan Valley Depression corresponds to the subtropics and this area is one of the world suited production places of orange and lemon as well as winter vegetable production center supplying not only to the cities in the country but also exporting to surrounding Arabian countries such as Lebanon, Syria, Iraq and Saudi-Arabia. Amman (31°59'N, 35°59'E, 776 m Al.) is selected as one of the highland civilized places in the country. Although its altitude is 776 m but it corresponds to a 1,000 m calculating from Jordan Valley Depression ( $776 + 224 = 1,000$ ), and also corresponds to a warm temperate area.

### CHAPTER 3. DISCUSSION ON THE CHARACTERISTICS OF BANGLADESH CLIMATE IN COMPARISON WITH THOSE OF CONCERNED COUNTRIES

#### 1. CLIMO-METEOROLOGICAL DISCUSSION WITH THE CLIMATE GRAPH OF DACCA

At the first glance of climatic graph of Dacca in Fig. 1, it is very impressional that the curves of relative humidity and temperature express clearly or more clearly than what every one stayed in Dacca throughout a year has felt by his body.

##### (1) On the Humidity Condition

A. The minimum humidity changes widely from nearly 45 % to more than 85 % while the maximum does not change so much. The former expresses those of afternoon or roughly say the feeling in daytime and the latter expresses those of midnight to early morning or roughly say the feeling in night time. Less range of the maximum means almost every morning dew fall comes even in dry season caused by a good dropping down of the temperature.

B. As a whole, the range between the maximum to minimum or simply say the minimum value expresses the humidity condition that those from November to March are very dry while those of June to September are extraordinary wet ranging daily only about 85 % to nearly 95 %, actually the minimum value of August is higher than the maximum of March.

C. Reading daily data of humidity on every day's newspaper, the expert had realized that the day having 92-98 % had continued for more than 2 weeks in July and August, that is, as if in a Turkish bath.

D. The remained months of April, May and October have intermediate value.

##### (2) On the Temperature Condition

A. The range of the maximum and minimum changes again widely from more than 13°C to less than 5°C which seems to be extraordinary case in the world.

B. The maximum temperature curve figures two peaks, the first in April and the second in September and October, depressing in June to August, while the minimum curve figures only one peak almost levelling from May to September.

C. This shape is also very impressional and unusual, perhaps in the world since no other place having so clearly curious climatic curves has been found as far as the expert examined in S-E Asian countries as well as Middle East countries. This shows clearly the reason why the plant growth in Bangladesh expressed so impressional response in different season as explained later in detail.

##### (3) On the Precipitation Condition

A. Much amount of precipitation from May to September while very less from November to March and intermediate in remained months.

B. This clear difference between rainy season and dry season is not so much special or more or less the same as the subtropics and higher latitudinal tropics of S-E Asia as seen in Table 2.

#### (4) General Discussion

##### A. General Remarks

(a) It should be said generally that the temperature condition is firstly settled by the degree of latitude in lowland and the humidity is firstly affected by the precipitation but not always conclusively.

(b) It can be also said generally that the range of maximum and minimum temperatures, (air temperature in this case) is affected mainly by the humidity condition or the amount of water vapour in the air, that is, the more the water vapour is in the air, the less the rate of up and down of the temperature becomes, acting the water as a buffer of temperature change. More precisely say, when the air temperature is going up, the water on the ground evaporates or the water particles in the air (mist) turns into real water vapour, and this phenomenon makes absorbing the evaporation heat (-583 cal/g at 25°C), consequently the air temperature is checked upping at this rate, on the contrary, when the temperature is going down, this action is checked downing at the same rate with the opposite change of vapour to water, that is, with the phenomena of evaporation and liquefaction, the minus and plus effects of evaporation heat act as a buffur of the changes of temperature checking its upping and downing.

##### B. Effect of Humidity on the Temperature Condition with Fig. 1

(a) Accordingly, it can be understood that the reason why the maximum temperature becomes lower and the range of day and night temperatures become very less in June to September is the effect of extra-ordinary high humidity that is, 85 % of the minimum means extra-ordinary large amount of water vapour in the air referring more than 25°C of minimum temperature, approximately being dew point.

(b) With the impressionally difference of maximum and minimum temperature curves, the levelled peak of the latter from May to September seems to be also caused by the high level of water vapour content in the air.

(c) On the contrary, the wide range of temperature difference from December to March is affected by the less humidity like desert countries, no other S-E Asian place has such dry condition except Pai in Thailand. The high maximum temperature of March, April, May, September and October also caused by less humidity.

##### C. Effect of Air Current and Flooding Condition on the Climate of Bangladesh

(a) Inasmuch as the change of monthly precipitation per year in Dacca is rather common figures in the subtropics and higher latitude tropics of S-E Asia nevertheless the shapes of temperature and humidity curves are unusual, it can be concluded that the precipitation condition is not always conclusively affected on the curious change of temperature and humidity conditions in Dacca.



(b) The precipitation condition should be said the first factor for humidity condition, however, some other factors seem to affect this condition, perhaps they are air current and flooding condition of rivers and ponds.

(c) It is supposed that the climate of Bangladesh is deeply affected by the air current from Bay of Bengal during summer, May to October, with the cyclonic monsoon climate, while the winter climate, December to March, is deeply affected by the northern current from Himalaya Mountains.

(d) The flooding condition of rivers and ponds may also affect on the climate but the effect may be smaller than that of air current. It may affect delicately from place to place when each climate of different places in Bangladesh is examined precisely, in other words, this factor is a modifier on the climate.

#### D. Conclusion

(a) The impressional contrast of climate in summer and winter of Bangladesh is caused by the diametrically different of air currents in summer and winter. That is, the hot and unusually wet air current arised in Bay of Bengal blows up from south in summer not only bringing cyclones but also keeping highly humid air into Bangladesh during the marine high atomosphic pressure predominates to the continental one, which settles the extra-ordinary wetty summer of Bangladesh, while in winter, when the continental high atomosphic pressuare predominates to the marine one, the unusually dry cool air current which blows down from Himalayan Mountains with Foehn phenomenon settles the unusual dry condition in monsoon zone, and both make the curious climatic characteristics of Bangladesh.

(b) In a short, the summer climate corresponds to the tropical rain forest type, one of the marine climates, but more remarkable than S-E Asia, while the winter climate corresponds to the desert type, one of the continental climates.

(c) The former climate is typically expressed in June to September and the latter is typical in November to March as understood in Fig. 1. The remained months are the transitional period of the two remarkable seasons as explained in the next paragraph.

(d) The monsoon weather condition dvelops step by step from March following with the withdrawal of continental high atomosphic pressure, developing and pushing up the seasonal rain front gradually from April to May, which brings the cyclonic rain step by step increasing the times, from once in a week or 10 days at the beginning to 3-4 times or more per week from the end of May to June, and at last completes the monsoon rainy weather around at the end of June and enter into the dense rainy season.

(e) The difference between the raining condition between cyclonic rain and dense rain is that: while the former is short time heavy rain with strong wind of cyclone, the latter is long hour soft rain without wind which is the characteristics of stagnated rain front by bal-lace of south and north high atomosphic pressures.

(f) From around themiddle of September, the weather condition changes just contrary to the former, at first the seasonal rain front goes down to the south or away from the land to Bay of Bengal and the cyclonic rain comes again upto around the beginning of November,

meanwhile, the continental high atmospheric pressure develops step by step and at last the continental dry weather condition settles around at the middle of November. condition settles around at the middle of November.

(g) It is clear that the period of June to September can be said a highly humid hot season and November to February be a severely dried cool season, but the remained months are a kind of unsettled season and characterized by alternation of heavy rained wet condition and subsequent dryness by remarkable hot temperature and strong sunshine which affects severely worse on the plant growth as discussed in the following Chapter.

(h) It can be concluded by comparing with other countries that April and May as well as October showed be classified into a dry season in spite of having cyclonic heavy rains but counting quick drying up by severe hot temperature.

(i) As the conclusion, it seems to be proved correct that Bangladesh climate can be divided into four seasons of the 1st Cyclonic, Dense Rainy, the 2nd Cyclonic and Dry season as shown in the heading of Table 1 as well as the heading Table of Part 1, as far as veiwed from the vegetation or an agro-climatological aspect.

## 2. DETAILED METEOROLOGICAL DISCUSSION ON THE CLIMATE OF VARIOUS PLACES IN BANGLADESH

### (1) With the Climate Graphs

#### A. In General

Although all the climate graphs of several locations in Bangladesh figured this time for a trial have showed the same characteristics as that of Dacca, there are of course some extent of fruotuation with each location if compared in detail, that is, as shown in Fig. 1 to 4 representatively, begin moderate in Dacca's graph, Rajshahi's graph or the western part seems to figuring more stressed curves on the said characteristics than Dacca's, while that of Chittagong shows somewhat less stressed it, and that of Sylhet is somewhat particular.

#### B. On the Curves of Humidity and Temperature

(a) The graph of Comilla showed almost the same shapes as Dacca but a little dull in the shapes of minimum humidity curve (3-10 % higher in February and March and 2-3 % lower in April to August) and minimum temperature if compared with Fig. 1.

(b) The graph of Ishurdi showed almost the same shape as Rajshahi but a little sharper in the shapes of minimum humidity curve (4-5 % lower in January to April and 4-2 % higher in October to November) and minimum temperature curve (1-2°C lower in almost all months).

(c) The graph of Maijidi, Noakali Districts showed more or less the same shapes as Chittagong but the minimum humidity curve showed 5-7 % lower in January, March, April, October, November and December, sharper depression appeared on the maximum temperature curve (0.5 - 1.0°C lower in Aug. and Sep.) and the minimum temperature curve showed some deviation (0.5 to 1.0°C up and down in Nov. to Apr.).

(d) Although the climate of Sylhet must be classified in the west type, the climate-graph is something special in Bangladesh as seen in Fig. 4. Its maximum humidity curve shows clear depression in Feb., March and April as Dacca and Ishurdi being respectively 3.9 and 4% lower than Chittagong's, its minimum humidity curve shows also clear depression in Feb., Mar. and April being respectively 4, 15 and 6% lower than Chittagong's. With its maximum temperature curve, no clear depression appears but almost horizontal from March to October which seems to be special in Bangladesh. With the minimum temperature, generally the shape is more closer to Dacca's than to Chittagong's but the minimum temperature levels from Feb. to Nov. are always lower than even Dacca's, more over, the ranges of maximum to minimum from Jul. to Sept. are always wider than Dacca's. Referring the unusually large amount of rain fall in this period, the said condition can be said also special, and this evidence seems to be an example of the flooding condition, that is, due to Sylhet has less rivers than other central and south part cities.

### C. On the Rainfall

(a) Discussion on the total amount of precipitation per year is already described in Chapter 2-2-(2), that is, less in west part especially in north west, medium in the central part and south west, and much in the east part showing maximum at Sylhet.

(b) Showing a big diversity in precipitation amounts per year from place to place as mentioned the above, the largest precipitation months are concentrated in June to August throughout the country. Same places, however, show rather large amount in May but some places show notable amount in September, and this difference may be due to deviation in the settlement of time and period of the stagnated rain front place by place.

(c) The rainfall condition of Sythet should be said something special in Bangladesh and it is due to its topography, that is, only this place is sheltered by the mountain wall of Khasi-Jaintia in the northern back.

### (2) Combined Discussion with Graphs and Table 1

A. The most impressional fluctuation among the places have appeared on the depression of minimum humidity curves and on the first peak of maximum temperature curves in differences of grade, time and duration. For example, on the depression of minimum humidity, 53, 42 and 47% in Feb., March and Apr. with Dinajpur, 53, 44 and 46% in February, March and April with Rajshahi, 47, 40 and 41% in February, March and April with Ishurdi, 48, 44 and 52% in February, March and April with Jossore; 57 and 58% in February and March with Mymensingh, 58 and 54% in February and March with Dacca, 56, 50 and 58% in January, February and March with Comilla; 58 and 54% in February and March with Sylhet; 55 and 53% in February and March with Khulna; 59, 61 and 63% in January, February and March with Maijidi, 65 and 62% in January and February with Chittagong, 69, 67 and 68% in December, January and February with Cox's Bazar, and 53 and 48% with Rangamachi. As to the first peak of maximum temperature as seen in Table 1, it comes in April and May, ranging from 36.6°C with Rajshahi to 32.1°C with Maijidi, only Sylhet's curve does not show clear peak.

B. The above evidence seems to show the difference of power and duration of the continental high atomosphic pressure, that is, stronger and longer lasting in north west and weaker and shorter in the south eastern part. This may also show the time of earlier visit of

cyclone, that is, early in the south and south east and late in the north west. Sylhet has something special. It has the famous Khasi-Jaintih Mountains, the world biggest precipitation place (10,824 mm at Cherrapunji) like a maintain wall at just its back and this mountain keeps special air current or strong rain front stagnating for long duration, may be from April to October.

C. About the range of maximum and minimum temperatures:

(a) General change in a year show almost the same trend as Dacca throughout all the places of Bangladesh.

(b) Showing generally a similar trend mentioned in A, the wide range appearing around in January – March is more remarkable in the west part and less in the south-westmore places, that is, 16.5°–15.5°C in February and March of Ishurdi, 15.3°–13.9° in the same months of Rajshahi, 15.3°C in February of Dinajpur, 14.7 and 15.5°C in December and February of Jossore, around 13°C in around February of Mymensingh, Dacca, Comilla, Khulna, Sylhet and Rangamachi, while only 11.8°–12.6°C in the same months of Maijdi and Chittagong.

(c) The minimum temperatures of the coolest months of December and January fluctuate as 11.7°–10.6°C with Dinajpur, 12.6°–11.7°C with Rajshahi, 11.8°–9.9°C with Ishurdi, 11.4°–11.2°C with Jossore, 13.7°–12.1°C with Mymensingh, 13.1°–12.3°C with Dacca, 13.3°–12.2°C with Comilla, 14.6°–13.9°C with Khulna, 13.4°–11.9°C with Sylhet, 13.2°–13.2°C with Maijidi, 15.0°–13.9°C with Chittagong and 17.2°–15.6°C with Rangamachi.

(d) These figures show also the same trend mentioned in A and it is notable that Rangamachi is not a cool place but a warmest winter place despite of locating in mountain highland in Bangladesh, may be due to being not enough altitude (about 250 m.Al.) but also to its topography of surrounded by mountains which shelters the predominant continental cool current in the winter.

(e) The hottest April and May of Dinajpur, Rajshahi and Ishurdi do not mean the hottest as a whole Bangladesh because the minimum temperatures of them can read as 21.4°–23.8°C, 23.5°–24.9°C, 22.6°–24.4°C respectively while those of Chittagong reads 23.6°–24.6°C despite of its maximum reads 31.9°–32.4°C being the lowest maximum together with Sylhet.

(f) The above mentioned evidences may affect delicately on the plant growth as discussed in the following Chapter.

### 3. COMPARISON OF BANGLADESH CLIMATE WITH THOSE OF CONCERNED COUNTRIES

#### (1) With Japan, as a Temperate Zone Country

##### A. Climate of Nagoya

(a) In a glance of comparing Nagoya graph with Dacca, it can be understood how far different they are. The former can be said one of the typical examples of monsoon temperate climate. Remarkable up and down take place on the curves of temperature which make clear four seasons of spring (March to May), summer (June, July, August), autumn (September, Octo-

ber, November) and winter (December, January, February).

(b) Although the temperature changes monthly remarkably, the range of maximum and minimum temperatures is kept rather constantly about 9°–10°C. The range of maximum and minimum humidities is also kept rather constantly although the minimum curve shows some extent of fluctuation.

(c) As to the precipitation, there are 2 much rainy months of June and September and 4 less rainy months of November, December, January and February and remaining months as intermediate but the fluctuation from month to month is not seen so remarkable as in Bangladesh.

#### B. Climate of Karuizawa

(a) Karuizawa is listed up in Table 2 in order to show the meaning of highland, which climate belongs to the same type as Nagoya but showing about 6°C lower level of temperature than latter, and 4 months from June to September are comparatively much rain due to just a 1,000 m altitude mountain highland.

(b) Even in temperate zone, the average temperatures are much lower than Bangladesh, but Nagoya's summer especially in July and August is still hot for such mild weather preferring vegetables as cabbage, Chinese cabbage, spinach, radish, carrot, tomato, cucumber, snap bean etc. Therefore, cool summer of highlands like Karuizawa is utilized for the above mentioned vegetable production as highland summer vegetables, which season is from May to September.

(c) If you compare the temperature of those 5 months of Karuizawa with December to February of Bangladesh, it can be understood how similar they are, counting also the minimum temperature, and also understandable in roughly spoken that the winter weather of Bangladesh corresponds to spring and autumn or May, June, September and October of Nagoya or lowland of Japan, when most of vegetable enjoy their growth.

#### (2) With Taichung, as the Same Latitudinal Place of Dacca in the Subtropical S--E Asia

(a) In a glance, it can be understood that the climate graph of Taichung also belongs to Japanese type but the temperature levels are always higher than Nagoya's except August, especially so in the months from November to April which means the subtropics.

(b) The south part of Taiwan has clear dry season in October to January, the same but earlier months than Manila and Bangkok which belong to the same Pacific Typhoon area, may be the Pacific monsoon weather reaches Taiwan later than the southmore parts.

(c) North part of Taiwan like Taipei has different climate type which has rather rainy and cloudy winter and more alike to Back side Japan having rainy season in winter.

(d) Inasmuch as S--E Asian leaf and root vegetables are promising for the countermeasure of Bangladesh rainy season production, the climate of Taichung should be learnt because most of good varieties have been bred here.

**(3) With Thailand and Philippines (Luzon), as Examples of the Higher Latitudal Tropics**

**A. General Remarks**

(a) It can be seen such higher latitude tropics as Manila and Bangkok, around at 15°N, has still some extent of seasonal temperature changes controlled by latitudal position.

(b) In a glance, the climate graph of Manila shows some extent of similarity to that of Bangladesh though it is much vague, having two seaks on the maximum curve, one horizontal height on the minimum temperature curve from May to September one clear depression on the minimum humidity curve and remarkable peak on the maximum temperature curve around in April. In this respect, the climate of Bangkok is different to that of Manila.

(c) The above mentioned is supposed to be due to the difference of months which show the largest rainfall, that is, August in Manila but September and October in Bangkok.

**B. Important Comparison of Climates Related with Plant Growth**

(a) It is impressive that both Manila and Bangkok has common hottest month of April just the same as Bangladesh, may be mostly due to predominant fine days, that is, the last balance of continental high atomosphic pressure and marine one.

(b) The more important points on the comparison of Bangladesh with those places are:

- (i) The minimum humidity from April to November of Manila and Bangkok is always much lower than Bangladesh, that means Bangladesh climate is so wetty than S-E Asian Tropics and so dry in winter.
- (ii) The range of maximum and minimum temperatures of Manila and Bangkok does not show so big fluctuation as Bangladesh as seen in Table 2.
- (iii) Those two points show that S-E Asia has comparatively dryer weather in summer than Bangladesh, in the other words, it can be understood that how terrible the Bangladesh rainy season is for the plant growth.

**C. With the Highland Climate**

(a) Baguio of 1,500m altitude has a mild weather all year round which correspond winter of Bangladesh and Taichung. This place is called Salad Bowl of the Philippines but it has a weakpoint for vegetable culture, that is, too much precipitation from June to September and have the same condition of daily temperature difference during this season just as Bangladesh has, but much cooler than the latter's.

(b) As to Pai, it would be enough as explained in 1-(3)-D. The extra-ordinary big range of maximum and minimum temperatures, 17.2°, 18.5°, 21.6°, 22.8° and 18.9°C from December to April, is supposed to be caused by nightly blowing down of cool dry air current from high mountain along through the steep of mountainous valley.

**(4) With Malaysia and Singapore, as Examples of the Lower Latitudal Tropics**

**A. General Remarks**

(a) The Climate Graph of Kuala Lumpur as well as that of Singapore Shows quite different type to other places. The Temperature condition as well as humidity show almost constant figuring almost horizontal curves, that is, a typical figure of low latitudal tropics or equatorial area.

(b) The difference of maximum and minimum temperatures shows also almost constantly  $9^{\circ}$ – $10^{\circ}$ C, the same condition is seen also in the humidity.

(c) Showing some deviation on the minimum humidity curve, it is approximately  $62 \pm 3\%$ , therefore, the night humidity can be said quite moderate.

(d) The rainfall rate has two peaks and two depression, the former appears in May–April and November and the latter appears in June–July and January in Kuala Lumpur. In Singapore, the rainfall rate has also two peaks and two depressions in different season as seen in Table 2. At any rate, however, these equatorial places can be said rather evenly rainfall throughout a year in comparison with other higher latitudal places.

#### B. With the Highland Area

Tanah Rata is the principal town of Cameron Highlands in the mountains at the north of Kuala Lumpur and the famous highland vegetable production and tea estates are spread from Tanah Rata to more elevated place up to some 2,000 m. Al. The temperature condition of this town is very moderate throughout a year, some  $10^{\circ}$ – $11^{\circ}$ C cooler than Kuala Lumpur having  $8^{\circ}$ – $10^{\circ}$ C of the range of maximum and minimum. The rainfall is also almost evenly throughout a year. This area is very foggy place, therefore, very suitable for leafy vegetable and tea cultivation, better than Mountain Province of the Philippines. The expert has also realized the growth of vegetable in Cameron H.L. is better than Mountain Province by 3 time visitings each. This is one of the biggest shipping vegetable production areas in S–E Asian countries aiming at Penang, Kuala Lumpur and Singapore as well as other surrounding foot cities.

#### (5) With Jordan, as a Subtropical Desert Country

##### A. General Remarks

(a) Deir Alla is located at the center of east bank of Jordan Valley Depression.

Although it is situated at  $32^{\circ}12'N$ , it can be classified into a subtropics refering the temperature condition, perhaps due to so deep depression as -224 m. Al.

(b) The shape of climate graph of Deir Alla is completely different to that of Bangladesh and is rather comparable with that of Taichung.

(c) Comparing their monthly average of mean temperatures, January–February of Deir Alla is  $14.5^{\circ}$  –  $15.3^{\circ}$ C while those of Taichung is  $16.6^{\circ}$  –  $16.5^{\circ}$ C and July–August of Deir Alla is  $30.3^{\circ}$  –  $31.4^{\circ}$ C while Taichung is  $28.3^{\circ}$  –  $28.6^{\circ}$ C, that is, Deir Alla has  $1^{\circ}$  –  $2^{\circ}$ C lower winter but  $2^{\circ}$  –  $3^{\circ}$ C higher summer than Taichung has.

(d) Although the maximum temperatures of summer of Deir Alla especially from May to October are remarkably highter than those of Taichung but the minimum temperatures of Deir Alla from January to July are always lower than those of Taichung especially

3.5°C lower in rapidly arising months of May to June, while the minimums temperatures of August to December are almost the same as Taichung.

(e) Although only monthly average of mean relative humidities are available in both meteorological data, those of Deir Alla are much lower than those of Taichung, especially extremely low in the no rain months of May to November.

(f) The above mentioned show the typical climate of desert with Deir Alla, but it has some rainy season from November to April which makes a mild weather condition.

#### B. Vegetation Condition

(a) Although Deir Alla has so severe hot temperature as 38.3°–39.2°C in July–August without any rainfall, this town is a production area of excellent quality of Navel orange and lemon, it may be interesting to compare with the famous production area of Pong Kan, a tropical mandarine in Taiwan is nearby Taichung.

(b) Any how, the reason why Deir Alla or Jordan Valley can grow good orange and lemon, although it embraces problem of a physiological disorder, most probably B-deficiency, and virus infection in their culture, seems to be firstly due to having low minimum temperature, that is, never exceeds 23°C even in the hottest August. This point is very important to learn Crop Ecology.

(c) Except the hottest three months of July to August, Jordan Valley is a good production area of temperate zone vegetables such as tomato, cucumber, cabbage, radish, carrot, snap bean, even garden pea and broad bean.

In the hottest months of June to August such vegetables as watermelon, egg plant (brinjal) and sweet corn can be produced.

(e) Of course, those vegetation in Jordan Valley can be available only in case of providing irrigation facilities.

(f) The winter of Bangladesh is just comparable to the climate condition of Deir Alla and may be understood how important the wide range of the maximum and minimum temperatures is, especially in high temperature level.

#### C. With Amman

(a) The climate data of Amman are listed only for a reference of a highland condition in comparison with Deir Alla. This climate condition belongs to a complete temperate zone type. Although the maximum temperatures of June–August is somewhat warmer than Nagoya, Amman has a enough ability to produce summer vegetables in stead of Deir Alla which summer is not suitable. Why Amman can produce summer vegetables is due to the low maximum temperatures having also a range of 14.0° – 14.7°C temperature differences during those hottest five months.



#### CHAPTER 4. AGRO-CLIMATOLOGICAL DISCUSSION ON THE NOTABLE INDICATION OF VEGETATION FOUND IN THE SERIES OF TRIALS REPORTED IN PART 2

As discussed already everywhere in Part 2, there are many indications of impressional responses of plant growth which show the characteristics of agricultural ecology under special condition of natural environment of Bangladesh. This chapter is written in order to clear the agro-climatical evidences found in chapter 3 in proof of the above mentioned crop-ecological discussions pointed out in Part 2.

##### 1. DISCUSSION ON THE GENERAL POINT

###### (1) On the Designed Four Seasons

A. The expert has designed the 4 seasons of the 1st Cyclonic, Dense Rainy, the 2nd Cyclonic and Dry as described at the head Table of Part 2 with his own idea referring his experience during his two year stay in Bangladesh, despite of knowing that there are a few forerunner's ideas classifying Bangladesh seasons into 6, each of which may have enough evidences to set up itself. He believes that his design could be convenient to understand Bangladesh agricultural seasons clearly with its vegetation responses in each different season.

B. Although the idea can be got intuitionally from the climatic graphs of Bangladesh, the evidence to set up the 4 seasons seems to be also cleared completely in the discussion of Chapter 3-1-(4)-D concluding at D-i. The bases are:

(a) On the Dry Season: There would be no objection to set up this season but the reason to set up the beginning border at around 10th of November is the last cyclonic rain may end by this date and the closing border is settled counting the first cyclonic rain may begin averaging at the end of March. No more worry of heavy rain and the temperature is rapidly getting down and mild around from the middle of November while the winter crops may last till the middle of March since the temperature comes up suddenly around the end of March as well as the day length is getting long bordering at the vernal equinox day.

(b) On the 1st Cyclonic Season: It is set up as a vernal traditional period when the weather is unstable by frequent visit of cyclones in Bangladesh as explained in Chapter 3-1-(4)-D-d and e. As explained in the same D-h, this season is better to understand a kind of dry season rather than so called rainy season as viewed from the balance of precipitation and temperature levels remarked in Chapter 2-1-(1)-A. The vegetation in this season shows also a kind of dry weather response as discussed in the following section.

(c) On the Dense Rainy Season: It is set up as a typical rainy season when the rain front is stagnant on the land, while the cyclonic rains in the former or latter seasons are brought by the moving rain fronts. Rains in this season is corresponding with Baiu, the rainy season of Japan which caused by big and long stagnating rain front as a characteristics of Asian monsoon temperate zone, but that of Bangladesh is far much bigger and longer than Japanese one. Because of long lasting soft rains without wind, it was named Dense Rainy Season.

(d) On the 2nd Cyclonic Season: The weather return back again predominated cyclonic

rains caused by moving rain fronts around from the middle of September. The day length is getting short from autumnal equinox day. Fine day becomes predominant, therefore, it can be said also a kind of dry season but the humidity of this season is somewhat higher than the 1st, may be, caused by still kept flooding water.

## (2) On the Diametrical Difference of Vegetation between Dry and Rainy Seasons

Outline of the difference of weather conditions between Bangladesh summer and winter affected on the plant growth may be already understood by readers by a glance of the climate graphs and the explanations up to here. Therefore, the expert wants to write the matters hereafter summarizing the discussion hitherto.

### A. Severeness of Rainy Season

Severences of the weather in Dense Rainy Season can be summarized in (i) the high humidity, always more than 85 % which can be said unusual comparing with other S–E Asian countries on the minimum humidity levels, (ii) the small range of day and night temperatures, always only 5°C which is also extra-ordinary in the same comparison, and (iii) unusually high minimum temperature, nearly 26°C which cannot be found in other S–E Asian countries in monthly average data.

### B. Vegetation Response on the High Humidity Condition

(a) Disadvantage of high humidity on the vegetation is of course to grow elongated, soft and juicy plant especially in case followed with cloudy condition, which becomes to be susceptible not only to various diseases and pests but also to different condition, for example, strong sun light and dryness if follows subsequently. This physiology is accelerated under higher temperature condition.

(b) Sometimes, however, this condition produces better quality of leafy vegetable and Kang Kong cultivation during this season is one of the benefitable example, but Bangladesh dense rainy season cannot be acceptable generally for leaf vegetable cultivation especially for temperate zone varieties due to its unusually high temperature level and never comparable to the condition of Cameron Highlands mentioned in Chapter 3-(4)-B, a high humidity under mild temperature.

(c) A single advantage of this season is easy to make vegetative propagation. Cutting, layering and grafting practices as well as transplantation can be very easily succeeded. This condition can be utilizable more in fruit tree and tea culture than vegetable horticulture, for example, in other countries this condition is artificially installed by a mist-blower in greenhouse, called Mist-House, but it is happy for Bengalee people that the same condition is naturally installed by God.

(d) It is, however, the reason why the expert has emphasized to advice to change the local gourds and cucurbitaceous crops into transplanting culture utilizing a pot raising seedling method, in order to extend their production period.

### C. Bad Effect of Less Range of Temperature Difference or High Minimum Temperature

(a) In this respect, it would be needless to mention here so much because it has been discussed repeatedly in Part 2. The expert would like to mention here only about the fact how severe the Bangladesh condition is in comparison with other countries.

(b) Please compare the graph and meteorological data of Bangladesh with those of similar places of Taichung, Manila, Bangkok, Kuala Lumpur and Singapore. Also, refer the fact that even the maximum temperature is high if the minimum goes down adequately the vegetation improves very much as smooth as explained with Jordan Valley in Chapter 3-3-(5)-B-c and C.

(c) The reason is simple that under high night temperature condition, the assimilated carbohydrates are wasted at right remaining less balance of metabolism; the higher the temperature is, the less the balance becomes.

D. The Reason Why Temperate Zone Vegetable Cannot Grow Well in the Summer But Good in the Winter

(a) General reason is the same as explained in the above.

(b) By means of examining the climatic condition of temperate zone comparing the condition of spring and autumn of Nagoya, summer of Karuizawa as well as all season of Tanah Rata, Cameron Highlands as explained in Chapter 3-3-(1)-B and (4)-B, the climate condition preferred by temperate zone vegetables can be understood and also how terrible the summer condition of Bangladesh is.

E. The Reason Why S–E Asian Vegetables are Suited to the Rainy Season of Bangladesh

(a) By means of comparing the climate conditions, it can be said that Manila, Bangkok and Kuala Lumpur have rather similar temperature condition to Bangladesh rainy season.

(b) Taking radish as an example, tropical Chinese radish is far more suited to the said condition than Japanese radish as examined in the trials, that may be due to the former had been developed them under the condition of tropics and subtropics in every meaning. One of the reasons of adaptation of tropical Chinese radish is due to its earliness as well as having tender and upright leaves with which the varieties can be harvested in early stage as a combined use of root and leaf as well as grown in a dense spacing.

## 2. DISCUSSION ON THE PARTICULAR POINTS

### (1) On the Physiological Disorder of Radish and Other Vegetables in Cyclonic Seasons

#### A. General Discussion

The physiological cause of this disorder supposed to be mainly due to Born deficiency has been already discussed in detail in Chapter 2-4-(2) and Chapter 11-14-(3). It has been generally caused by severe dryness under hot weather by strong sunlight subsequent to saturation of soil by heavy rain in the cyclonic seasons.

## B. Agro-Climatical Discussion

(a) As pointed out in Chapter 3-1-(4)-D-h, the hot temperature peaks appears in April-May and September-October is one of the characteristics of Bangladesh climate and this condition is characterized by the above mentioned severe alternation of wet and dry but can be said generally belong to a kind of dry season.

(b) The symptom of this disorder showed a typical symptom of Boron deficiency which happens usually under dry condition of soil.

(c) It is interest that citrus cultivation was suffered from boron deficiency together with iron deficiency in Jordan Valley and the climate of Dier Alla is characterized similar hot temperature and severe dryness as seen in Fig. 10. The temperature condition of April in Bangladesh is more or less similar to those of May, Jun, September and October of Deir Alla and if count the flooding irrigation on the citrus orchard there, the condition of Jordan Valley is more alike to the cyclonic condition of Bangladesh.

## (2) On the Severe Damage of Virus Infection Observed in Tomato and Cucumber Trials

### A. General Discussion

Physiological discussion on this problem which is supposed to cause this severe damage in combination with virus infection has been already done in detail in Chapter 11-14-(3), that is, supposed to be similar physiological disorder appeared in radish, cabbage and cauliflower caused by the same weather condition.

### B. Agro-Climatological Discussion

(a) General condition of this disorder should be the same as the above (1).

(b) In this connection, the expert reminds that when he visited in May of 1976 a vegetable enterprise farm installed with modern drip irrigation system at the south part of Jordan Valley where temperature condition is somewhat hotter than Deir Alla, he noticed that a severe damage by virus infection was happened in tomato field, about 2/3 of plants were already killed just similar to those seen in the trial this time in Bangladesh, that is, a heavy irrigation was being done on the ground.

(c) The similar damages of virus on tomato and bell pepper were vastly seen also in Egypt. The most severe examples had been in April and May there, that is, around in 1966-67. Unfortunately the expert could not present here meteorological data of Egypt being unavailable to his hands, but with his experience the climate condition of Egypt was guessed to be quite similar to Deir Alla except precipitation which is almost no rain throughout a year in Cairo and the southmore places.

(d) Accordingly, the expert feels a quite common point among the facts of virus damages of tomato in Dacca, Jordan Valley and Egypt.

(e) Another notice of him is that when he visited Kuala Lumpur at the beginning of November, 1978, he noticed the okra culture there was not suffered of virus infection as seen

in April and May in Bangladesh. Moreover, when he visited Johore of Malaysia at the beginning of August, 1975, he was surprised by the fact that tomato was growing very smoothly on the upland place of suburban area of Johore Bahru being not more than 50 m altitude although the variety was heat tolerant variety of Money Maker strain. Examining the meteorological data of Kuala Lumpur, it can be found that the temperature condition there is supposed to be not as severe as Bangladesh summer being the maximum 31° – 32°C keeping 9° – 10°C range of temperature, and humidity condition is mild. The expert supposes that this rather mild weather condition might be settled such good tomato production in Malaysian lowland.

(f) At the times of his stay in Egypt and visit in Jordan, the expert used to advice on the severe damage of virus infection of tomato there that those damage must be a combined damage of virus infection with physiological disorder or mulnutrition of plant growth.

(g) The physiological disorder on the plant under desert condition was supposed to be caused by an accumulation of salts or alkaline in the soil, the mechanism is that in case of quick and severe drying up of soil happens, soil water concentration in the soil is certainly goes up and as the result with antagonism among soluble ions, the weak cation such as Ca, Mg, B, Fe etc. may be precipitation in turn from the weaker cations, that is the mechanism of minor element deficiency, and it is quite sure that those antagonism is happening under the said condition.

(h) Now, the expert considers sharply that there might be a common condition to cause similar physiological disorder between Egypt, Jordan and Bangladesh though, in a sense, it seems to be a big scientific adventure.

Many common conditions can be counted as follows:

- (i) The dry season condition of Bangladesh can be classified into desert climate
- (ii) The weather of cyclonic season, at least in April, May and around the beginning of October, corresponds to the climate of Jordan Valley and Egypt if counted its servere hotness and quick drying condition subsequent to shower rain in Bangladesh as the same condition of quick drying happens subsequent to flooding irrigation or heavy furrow irrigation in Egypt and Jordan.
- (iii) The soil of Bangladesh especially in the flooding area of Ganges Rivers and Brahmaputra is alkaline containing much Calcium.
- (iv) The water of the two Rivers is a hard water containing much Calcium and other cations. It is not curious if consider the rivers are running from desert lands of India and Tibet stemed from south and north sides of Hymalaya.

### (3) Combined Conclusion of (1) and (2)

As the conclusion of (1) and (2), the expert would like to suggest a reserch work on the physiological disorder to confirm the above mentioned hypothesis.

### (4) On the Improvement of Raising Seedlings

The expert suggested this point of protecting nursery bed from the heavy shower rains and strong sunshine in the cyclonic season everywhere in Part 2. The reason of this necessity can be realized by the above discussion on the special severe climatic condition of those seasons.

(5) On the Reason Why the Seeds of Temperate Zone Varieties Cannot Be Produced but Those of Subtropical Varieties Can Be in Bangladesh

(a) The expert has repeatedly noticed the said problem with leaf and root vegetables everywhere in Part 1 and Part 2, that is, in a short, due to the temperate zone varieties need a coldness of  $0^{\circ}$ – $5^{\circ}$ C (some extent available up to  $10^{\circ}$ C) for long time for their flower induction while the subtropical varieties do not need so much low temperature, perhaps available around at  $15^{\circ}$ – $20^{\circ}$ C.

(b) Examining the differences of minimum temperature conditions between Bangladesh and Nagoya, and Bangladesh and Taichung, the above mentioned condition can be clearly understood. That is, (i) Bangladesh has no month at all showing lower than  $10^{\circ}$ C in the minimum while Nagoya has such month for 6 months from November to April and (ii) Bangladesh and Taichung have commonly months showing lower than  $20^{\circ}$ C in the minimum for more than 4 months from November to March or April.

(c) Accordingly, the expert wants to suggest "Please don't make unfruitful efforts in this respect."

– the end –

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