Current Situation on Rice Production and Heat Stress Needed to Be Serious for Future Myanmar

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Abstract: Rice is major food crop of Myanmar. The total rice area was 8.1 million hectares of which 6.69 million hectares are sown during monsoon and 1.41 million hectares in summer in 2007-2008. Total rice production was 31.45 million tons with the average yield of 3.93 t ha^{-1}. To attain the national target, yield per unit area must be 5 t ha^{-1} and attempt has been made all possible ways. There are three seasons in Myanmar, as monsoon, winter and summer seasons. Generally the country can be divided into four regions as delta, coastal, central dry zone and mountainous areas. There are different weather in different regions. Depending on the time of sowing, rice cultivation can be classified as monsoon rice (May- October) and summer rice (October- April). Monsoon rice occupies the majority sown area. Summer rice is planted on November -February in delta region of lower Myanmar and on January-March for central dry zone regions. For specially, central parts of country, as Sagaing, Magaway and Mandalay divisions are dry zone areas where there are low rainfall with higher temperature effect. It was found that day maximum temperature were 39-43° C in summer season of those regions. There may be some problems in rice on heat stress over there. But there were any research findings on excessive heat in field condition. Myanmar becomes necessary to be serious to do research program on heat stress for future. Even thus, it will be safe to increase future rice production of Myanmar. There are some international research collaboration on different rice ecosystems between IRRI and DAR. Among these, Rice Heat Tolerance nursery included to identify the tolerant varieties. From this nursery, it was observed only general information on spikelet fertility. Exactly information on stress could not be known because of limited facilities for measurement of daily weather condition at flowering time. That is why specific project will be helpful to assess climate change impact on rice production of Myanmar.

1. Introduction

Myanmar, one of the ASEAN member counties, is endowed with rich natural resources : cultivable land, available water resources and favorable climate. The country's economy mainly relies on the agricultural sector, sharing 38 percent of GDP, 46 percent of the national export value.

The Union of Myanmar is located between 9° 58′ and 28° 31′ N latitudes and 92° 10′ and 101° 9′ E longitudes. The total land area is 676,577 sq km., with the length of 2200 km. extending from the North to the South, and 950 km. from the East to the West. Administratively, the country is divided into 7 states and 7 divisions: Kachin, Kayar, Kayin, Chin, Mon, Rakhine, Shan states and Sagaing, Taninthari, Bago, Magway, Mandalay, Yangon, Ayeyawaddy divisions. Myanmar is bordered with five neighboring countries and has a very long coastal line of about 2,234 kilometers along the Bay of Bengal, Gulf of Mottama and Andaman Sea.

Country	Location
1. Bangladesh	West
2. India	North-west
3. China	North and Northeast
4. Laos	East
5. Thailand	South-East
6. Bay of Bengal	West
7. Andaman Sea	South

2. Physical Features

Myanmar as a whole is a mountainous country. It is surrounded by mountains on all sides except in the south, which stretches out into the Andaman Sea. Myanmar can be divided into four distinct physical units:

1. The western mountain ranges,
2. The Shan (or) eastern highlands and their continuation into Taninthari,
3. The central basin commonly known as Ayeyawaddy basin and
4. Rakhine coastal strip.

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3. Water Resource

There are four major rivers namely the Ayeyawady, the Chindwin, the Sittaung and the Thanlwin from the north to south into Andaman Sea. The Ayeyawaddy and its major tributary, the Chindwin, are navigable through the centre of the country, and many small rivers of the Ayeyawaddy create a vast fertile delta region before flowing into the sea. The available water resources in terms of annual discharge rate of the four major rivers and other rivers system are estimated to be about 354.95 million hectare-feet of total annual flow.

4. Climate

The tropic of cancer passes through the northern part of the country near Chin State, Sagaing Division and Northern Shan State. Hence, the northern most part, about one - fourth of country, is in the temperate zone and remaining southern three-fourth of the country is in the tropic, 97° 30 East longitude forms the standard meridian for the country's standard time. There are three seasons in Myanmar, the hot and dry season lasting from mid - February to mid - May, the rainy season from mid - May to mid - October and the winter season from mid - October to mid - February. The southwest monsoon provides the major source of rainfall for the country. Generally, the country can be divided into four regions as Delta, Coastal, Central dry-zone and Mountainous regions on different ecosystem. There were different climates for different region as follows;

Table 1. Rainfall and Temperature of different Regions (1986-1995 and 1996-2005, 10 years Average)

Sr. No.	Region	Rainfall (mm)		Temperature (°C)						RH%
				Minimum		Maximum		Mean		
		86-95	96-05	86-95	96-05	86-95	96-05	86-95	96-05	96-05
A.	Delta region									
1.	Ayeyawaddy	2396	2957	10.0	22.3	40.0	32.6	25.0	27.5	80.1
2.	Bago	1953	3286	10.0	19.8	40.3	32.7	25.2	26.3	79.8
3.	Yangon	2638	2826	10.0	20.9	40.0	33.2	25.0	27.1	81.1
4.	Mon	4780	5188	10.8	22.4	39.0	32.3	24.9	27.4	76.8
B.	Coastal region									
1.	Rakhine	4070	4897	20.1	22.1	40.0	30.5	30.1	26.3	79.7
2.	Taninthari	4894	5663	10.0	21.1	38.0	32.1	24.0	26.6	78.8
C.	Central dryzone									
1.	Magway	880	884	8.9	19.9	46.0	34.0	27.5	26.95	70.6
2.	Mandalay	965	847	8.0	22.0	43.6	34.0	25.8	28.00	66.5
3.	Sagaing	1342	706	7.0	21.6	43.3	34.2	25.2	27.90	67.2
D.	Mountainous regions									
1.	Kachin State	2313	2370	7.0	19.0	41.5	30.2	24.3	24.6	76.3
2.	Chin State	1741	1449	2.4	14.2	33.3	23.6	17.9	18.9	70.2
3.	Kayar State	1011	1068	10.8	17.2	37.0	29.3	23.9	23.3	68.3
4.	Kayin State	4111	4395	9.4	22.3	40.3	33.6	24.9	27.9	76.6
5.	Shan State	1282	1290	0.3	15.4	32.9	27.9	16.6	21.7	71.7

5. Current Rice Production in Myanmar

Rice is not only a staple food in Myanmar daily diet but also one of the major food export items. The total rice area was 8.1 million hectares of which 6.7 million hectares are monsoon rice and 1.4 million hectares are summer rice in 2007-2008. Total rice production was 31.45 million tons with the average yield of 3.93 t ha^{-1}. To attain the national target yield , yield per unit area must be 5 t ha^{-1} and attempt has been made all possible ways.

Table 2. Rice Production in Myanmar

Year	Sown Area (mha)	Yield (t/ha)	Total Production (m ton)
1960 - 1970	4.98	1.66	8.10
1971 - 1980	5.00	1.92	9.60
1981 - 1990	4.87	2.87	13.97
1991 - 2000	5.14	3.63	18.60
2001 - 2002	6.41	3.42	21.91
2002 - 2003	6.38	3.42	21.80
2003 - 2004	6.53	3.54	23.14
2004 - 2005	6.81	3.64	24.75
2005 - 2006	7.58	3.74	28.37
2006 - 2007	8.13	3.83	30.92
2007 - 2008	8.10	3.93	31.45

Table 3. Rice Sown Area and Average Yield (t/ha) for Different Regions (2007-2008)

Region	**Rice sown Area** (000'ha**)**		**Average Yield (t / ha)**	
	Monsoon	**Summer**	**Monsoon**	**Summer**
Delta region	3.1	0.81	3.6	4.2
Coastal region	0.67	0.02	3.4	3.6
Central dryzone	1.80	0.48	3.9	4.5
Mountainous regions	1.12	0.10	3.1	3.9
Union Total	6.69	1.41		

In Myanmar, monsoon rice occupies the majority sown area and it is widely grown in various parts of the country. Depending on the time of sowing , rice cultivation can be classified as monsoon rice (May - end of October), and summer rice (October - end of April).

The planting time of summer rice varies from region to region, depending on its geographical and climatic conditions. In lower Myanmar, summer rice is planted from November to February to escape the rain at harvesting time. The wet season generally begins in May in coastal and delta region. On the other hand, summer rice is cultivated from February to March on the central dry zone region which normally receives rain in June. In the mountainous region, it is usually sown in February and March to escape the devastating effect of low temperature.

Table. 4 Rice Area Distribution under Different Agro-ecosystem

Agro-ecosystem	**% of total sown area**
- Favorable rice ecosystem	**68**
- Irrigated lowland	20
- Rain-fed lowland	48
- Unfavorable rice ecosystem	**32**
- Deepwater	5
- Submergence	9
- Salt affected	3
- Upland	3
- Drought-prone	12
Total rice sown area	8.1 m ha

Table 5. Breeding and Research for Target Environments in Department of Agricultural Research (DAR) , Myanmar

Rice ecosystem based breeding program for;	
❖ Favorable rice ecosystem	- Irrigated lowland - Rain-fed lowland
❖ Unfavorable rice ecosystem	- Submergence area - Drought-prone - Salinity - Upland - Deepwater
❖ Disease and Pest resistance ❖ Quality rice improvement ❖ Hybrid rice breeding program	

Table 6. International Rice Research Collaboration between DAR and IRRI (1979-2008)

Agro-eco system	Nurseries	Tested Locations	State / Region
Irrigated Lowland	IIRON	Yezin, Kyaukse	Mandalay Division
Rainfed Lowland	IRLON	Yezin, Leptan, Myangmya	Mandalay, Bago and Ayeyarwaddy Division
Upland Rice	IURON	Aung Ban	South Shan State
Water Saving Rice	AERON	Yezin, Sebin	Mandalay Division
Drought Tolerance	IRDTN	Sebin	Mandalay Division
Submergence	IRLYN (SS)	Pathein	Ayeyarwaddy Delta Area
Heat stress Tolerance	IRHTN	Yezin	Mandalay Division
Temperate Region Rice	IRTON	Taryaw	Northern Shan State
Soil Stress Tolerance	IRSSTN	Letpadan	Ayeyarwaddy Delta Area
Fine & Aromatic Rice	IRFAON	Yezin	Mandalay Division
Resistance to Bacterial Blight	IRBBN	Yezin	Mandalay Division
Resistance to Brown Plant Hopper	IRBPHN	Yezin	Mandalay Division
Resistance to Stem borer	IRSBN	Yezin	Mandalay Division

6. Heat Stress needed to become seriously on rice production of Myanmar

It was known that Global warming will likely increase occurrences of extreme heat events, which will be a major concern for the future crop production. And, excessive heat, might reduce yield of crops due to failure of reproductive growth, but information with regard to severe yield losses due to heat events has been limited and threshold temperature above which severe yield losses occur is still not clear under field conditions as well as in Myanmar.

Generally, the highest temperature (42-43°C) was found during months of March, April and May in summer season. For specially, central parts of Myanmar, Sagaing division, Magway division and Mandalay divisions are dry zone regions where there are 0.86 m hectares of summer rice irrigated areas. It was found that maximum in 39.95° C of local temperature for Mandalay, 42.52° C for Magway and 39.2° C for Sagaing division (Table- 7). It was known that the most suitable temperature were within 30-33° C needed for normal fertilization at flowering time of rice. According to the local weather condition of these dry zone areas, there may have some problems on heat stress. But, there was not yet research studies on excessive heat for rice production of these area.

Table. 7 Monthly Rainfall and Temperature of central dry zone areas for 10 years average of 1999-2008.

Month	Sagaing division			Mandalay division			Magway division		
	Rainfall	Temperature (°C)		Rainfall	Temperature (°C)		Rainfall	Temperature (°C)	
	(mm)	Min	Max	(mm)	Min	Max	(mm)	Min	Max
January	2.50	12.51	32.20	2.00	10.90	33.30	0.25	10.78	32.67
February	0.50	15.36	36.95	1.00	12.44	35.83	-	11.31	32.67
March	1.80	16.12	34.07	5.00	15.56	39.42	0.25	15.47	42.42
April	26.00	21.33	42.54	42.80	20.48	40.95	0.38	20.84	42.73
May	95.30	22.23	41.03	162.00	22.12	39.47	13.50	26.89	42.40
June	82.30	23.97	39.66	68.80	23.61	37.47	15.50	27.27	38.58
July	45.00	4.22	38.86	46.80	24.09	37.19	10.60	26.90	36.82
August	102.00	23.66	38.33	99.50	23.69	36.87	11.58	27.17	35.01
September	125.00	23.22	37.36	164.50	23.61	36.73	20.08	26.78	35.80
October	111.80	20.46	35.83	151.30	20.96	36.47	12.63	20.32	35.64
November	16.00	16.22	38.60	46.00	16.31	34.09	2.25	13.64	32.37
December	1.30	12.06	29.97	4.30	12.04	32.09	0.50	12.42	35.87
Total	609.30	231.36	445.44	793.80	225.84	439.88	87.50	239.79	442.98
Average	50.80	19.28	37.12	66.20	18.82	36.66	7.30	19.98	36.92

7. Current Research Program On Temperature Effect

International Observational Nursery on Heat Tolerance (IRHTN) nursery from IRRI by INGER program was conducted at Yezin, Naypyitaw, Myanmar in 2009 dry season with 23 entries in a randomized block design with three replications. Plots were $7m^2$, spacing was 20x20 cm with single seedling per hill. The general reference for data collection was the " Standard Evaluation System for Rice" (SES, 1996). Entry data was based on seedling vigor, plant height, days to heading, spikelet fertility and sterility, Phenotypic Acceptability at maturity and grain yield per plot.

Anthesis or blooming is the only reproductive stage at which rice plants are sensitive to high temperatures. Spikelet sterility is mainly attributed to pollen desiccation. Preliminary observation was carried out on the effect of maximum day temperature during anthesis. It was reported on spikelet sterility of (23) entries at the maturity stage in Yezin. It was found that 11 varieties looked tolerant to high temperature effect at blooming. Those had low sterility at range of (3.1-25.0 %) with high seed yield. Varieties G12A126, IDSA 77, DADRI, CUIA BANA, BASMATI 370 and MULAI suffered from maximum day temperature (37-39° C), their sterility percentage were 40.28-61.2. And Dular, IR 2307-2472-1, IR 8, Manawthukha (CK), IR50, IR 36,G 12A172,IR 19746-28-2-2, CR 547-1-2-3, WAB 56-125 and GHARIB suffered the lower percentage with higher temperature of 35-40.5° C at flowering time, their sterility were in a range of 3.1-25.04 %.

Table 8. Effect of different maximum day temperatures at blooming on spikelet sterility of different varieties 2009 Ws, Yezin, Naypyitaw, Myanmar

Sr. No.	Variety	Sowing date	Date of 50% flowering	Temperature at anthesis (° C)	Day Maximum Temperature (° C)	Sterility %	Yield t/ha
1	IR 1516-228-3-3	31 Dec 08	21 March 09	31	38.5	25.04	4.42
2	GIZA 176	/	19 March 09	31	37.0	59.61	2.07
3	DULAR	/	21 March 09	30	38.5	8.94	5.56
4	IR 2307-247-2-2-3	/	11 April 09	31	40.5	9.93	5.14
5	IDSA 77	/	3 April 09	28	39.0	57.18	1.50
6	IR 8	/	4 April 09	28	40.0	7.19	5.57
7	Manawthukha (CK)	/	20 April 09	29	38.0	7.15	6.61
8	VIALONE NANO	/	14 March 09	33	32.5	27.52	4.07
9	N 22	/	21 March 09	30	38.5	36.60	3.06
10	IR 50	/	20 March 09	29	39.0	11.83	6.21
11	IR 36	/	10 April 09	31	40.0	8.77	6.07
12	SADRI	/	23 March 09	30	39.5	40.28	1.06
13	CUIABANA	/	31 March 09	34	39.0	61.20	0.97
14	BASMATI 370	/	26 March 09	32	38.5	40.40	2.81
15	SAKHA104	/	14 March 09	30	37.5	23.56	3.48
16	MULAI	/	31 March 09	34	39.0	45.83	1.30
17	IR 22	/	9 April 09	30	41.0	3.03	5.61
18	GIZA 172	/	6 April 09	30	40.0	3.09	5.61

19	GIZA 178	/	3 April 09	29	39.0	35.99	3.99
20	IR 19746-28-2-2	/	28 March 09	30	38.0	11.16	6.37
21	CR 547-1-2-3	/	3 April 09	29	39.0	4.68	5.36
22	COAB 56-125	/	23 April 09	29	38.5	12.50	5.60
23	GHARIB	/	26 April 09	28	35.0	8.30	5.79

8. Needs for Future Program on Heat Stress

1. Research project on heat stress.
2. Advanced knowledge on heat stress for data management.
3. Human Resource Development.
4. Equipments for measurement on heat stress condition.
5. Local survey on heat stress in different regions of Myanmar.
6. International trainings or workshops.

9. Future expectation

- To improve research knowledge on heat stress.
- To find out the tolerant rice varieties on heat stress.
- To identify the specific region on climate change in Myanmar.
- To increase rice production for stress areas.

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