EFFECT OF WEATHER ON RICE CROP CULTIVATION: A CASE STUDY OF JIANGPU FARM, NANJING-CHINA

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ABSTRACT: *This study was conducted to observe the effect of different weather parameters on rice crop cultivation in Nanjing. During this study the rice crop was also cultivated at two different timings i.e., 22nd June and 10th July during year 2010 and 2011 at Jampoo farm of Nanjing, respectively. During these experiments seven different treatments were tested with only variation in application of water quantity, while all other input parameters were kept constant. At the end yields of same type of treatments were compared to observe the impact of cultivation timings. At the same time climatic data from 1987-2007 was also analyzed to observe the impact of temperature, humidity, rainfall, wind speed and sunshine hrs. It was observed that the crop cultivated on 22nd June, 2010 resulted 25.28% more production as compared to 10th July, 2011. At the same time the variation of temperature also shows that the 2nd week of May is proper for nursery growth or directed sowing of rice, so the 2nd week of June is best for transplantation.*

Key words: Climate, Rice, Temperature, Yield, field and cultivation timing

INTRODUCTION

The most common feed of the peoples on earth is rice among all other grain crops [1]. Climate change has adverse as well as positive effect on agricultural production. Although at some places agricultural production can also be increased but in most of areas climate change has adverse effects [2]. According to [3] about 20 million hectares of rice area will be affected by water scarcity up to 2025.

Due to rapid population growth and economic development it is necessary that the World rice production must be increased [4]. These increases must be achieved by getting more yields without increase in area under cultivation by taking care of environment, ecosystem and biodiversity [5 & 6]. By increasing total biomass more yields can be obtained, as of much scope to increase it [7]. Photosynthesis and respiration plays an important role in increase of biomass, but both are very sensitive to temperature [8].

The favorable mean daily temperature with 80% probability for safe sowing and heading growth is above 10℃ [9].

Rice, like other cultivated crops, has relative variable temperature preferences over the growing season. Deviation from the stage-dependent optimum temperature will alter the physiological activities or lead to a various growing ways [10].Although there are several studies carried out by crop simulation models to observe the effects of proposed future climate change on crop yields [11], a few field studies have also been carried out on the effects of climate change on agriculture [12 & 13].

Vegetative phase

During vegetative stage, rice can tolerate relatively high temperatures (35/25°C); expressing day/night temperature regime). Temperatures beyond this critical level could affect plant height, total dry weight and tiller numbers [14]. In a temperature gradient chamber study, rice exposed to 3.6 and 7.0 C higher temperature than ambient, from heading to middle ripening stage, reduced photosynthesis by 11.2–35.6%, respectively [15].

Reproductive phase

This stage is more sensitive to higher temperature as compared to vegetative stage [14]. Appearance of the anthers (flowering) is also the most sensitive process during reproductive stage to more heat [16 & 17]. Anthesis is very sensitive to high temperature and spikelets opening during the flowering period (5–7 days) could be affected differently depending on the duration of exposure.

Ripening phase

Grain quality and fertility is reduced as cellular and developmental processes are affected by high temperature [18]. There are other common affects of hot temperature at ripening stage are decrease in grain weight, reduction in fertility of grains, white chalky rice percentage increases and milky white rice [14 & 19]. In addition, increased temperature causes serious decrease in amylase content and grain size [20 & 21]. There was a significant effect of rise of minimum temperature on grain yield each 1°C increase causes 10% loss in yield, whereas the effect of maximum temperature on crop yield was insignificant [22].

MATERIALSANDMETHOD

Study Area

This study based on the experiments conducted during 2010-11, at Jampoo experimental farm, Nanjing Agricultural University, Nanjing, P. R China. Geographically it is located at 32º 02′12.15″N latitude and 118 º 37′ 47.95″E longitudes. Climate of the area is humid subtropical, influenced by the East Asia Monsoon. Summer is usually hot and the rainfall happens throughout the year. The annual mean temperature of Nanjing is 15.9 °C (60.6 °F), slightly below freezing in January.

Experimental setup and data collection

During this study, rice crop was planted in seven different treatments. These treatments were separated from each other by means of water applications only. During these experiments six innovative irrigation techniques were applied along with a traditional one also and the results were compared with each other along with a traditional technique too. The design of the experiment was randomized complete

block design with three replications. Each plot of 15m x 21m size was prepared and Irrigation depths of all treatments were kept different from each other. The rice plants were planted in row to row with the space of 20cm, while the plants were planted 15cm apart from each other. All the inputs i.e, fertilizer and pesticides applications were kept constant except water.

Rice variety of wuyungen No. 23 seed was transplanted in the field. The seed was first grown in nursery for 48 days that took 150mm water (30mm for 5 times). Four times fertilizers, pesticides were applied and weeding was also cleared four times from the crop.

Table 1 Monthly statistics of meteorological elements of Nanjing Area of 2010 to 2011

Month	Mean minimum Temperature (℃)		Mean maximum Temperature (℃)		Mean humidity（%）		Month sun shine (hrs)		Month rain fall（mm）		Month mean average wind speed（m/s）	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Jan	0.1	-3.4	8.4	4	67	57	122.2	156.1	18.8	10.8	2.8	2.5
Feb	2.7	1.2	10	10	77	70	83.5	109.4	115.6	17.2	3.2	2.9
Mar	5	4.7	13.3	14.7	71	56	129	205.2	117.8	43.2	4	2.8
Apr	8.8	11.7	17.4	23.2	69	57	166.7	229	197.9	11.6	3.5	3.1
May	17.2	17.4	25.8	28.1	69	57	169.8	231.5	56.1	40.6	3.3	3
Jun	21	21.2	29.3	29	72	77	160.7	124.2	62.1	312.9	3	2.9
Jul	25.4	25.3	32	31.8	81	79	154.5	144.4	343.2	278	2.7	2.5
Aug	26.2	24.3	33.9	30.9	74	80	240.8	137.4	142.1	284.3	2.7	2.8
Sep	21.7	20.1	28.2	27.3	83	71	140.2	157.2	181.1	12.6	2.8	3.1
Oct	13.8	14.3	21.7	21.9	73	69	160.6	155.3	32.1	28.7	2.8	3
Nov	7.4	11.6	17.8	19.3	66	73	177.6	133.4	7.6	21.3	2.2	3
Dec	2.3	0.9	12.2	8.6	55	65	193.7	161.2	24	15.8	3.2	2.7

The ridges of the treatments were covered with plastic sheets to assure the stoppage of seepage from ridges. Grain yield was determined from harvesting 1m2 area from three different places of each treatment randomly. All grains were dried at room temperature for 30 days and then weighted. Climatic data gathered from Nanjing University of information, science and technology, Nanjing, China. Meanwhile, the average temperature, humidity, sunshine hrs, rainfall and wind speeds were also re-confirmed from Nanjing Almanac [23], than used for analysis.

RESULTS AND DISCUSSION

Yield

Result shows that the average variation in yield of rice crop cultivated in late (20th) June, 2011 yields averagely 25.28% (six treatments) higher than cultivated in 2nd week of (10th) July, 2010 except one treatment, that treatment resulted 44.05% more production. The rest six treatments which cultivated on 20th June 2011 resulted 15.73%, 23.69%, 26.81%, 27.42%, 28.04% and 29.99% more production as compared to the 10th July, 2010. The minimum increase was found in the treatment that yielded the maximum, which was 15.73% (Fig.1).

Cultivation timings

For rice plantation minimum temperature is 10ºC, so in Nanjing Area best time of nursery as well as direct seeding starts after 10th of May while from last 15 years data it is concluded that it may be planted three days earlier (after 7th May) (Fig. 2). An experiment was conducted on single rice crop in Heilongjiang, Jilin and Liaoning Provinces of Northeast China and found that the low temperature is the main affected factor of the area [9].Whereas in Jiangxi province a datasets from fourteen agro-meteorological stations were analyzed at the same application rate of fertilizer in 1982 to 2005. It was found that the yield per area of early rice increased due to safe sowing time. It was also observed that early as well as late rice have positive correlation at accumulated temperature (>10℃) from sowing till heading [9].

Whereas rainfall data shows that July has the maximum rainfall followed by August but the more consistency observed in August. While, June stands third and may the fourth so because of continuity of rainfall, feasibility of direct sowing rice is less feasible then transplantation (>10cm, tall plant).

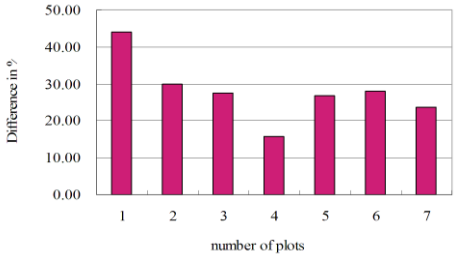

Figure 1. %age of less production obtained during late cultivation

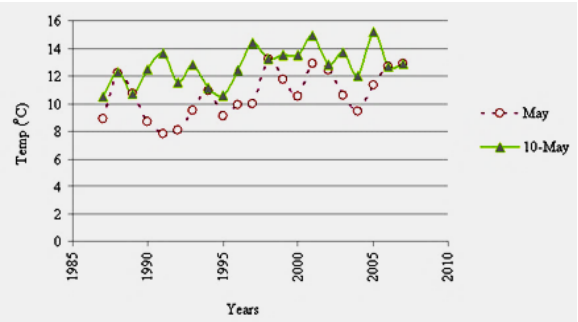

Figure 2. Minimum Temperature in full month and after 10th of May

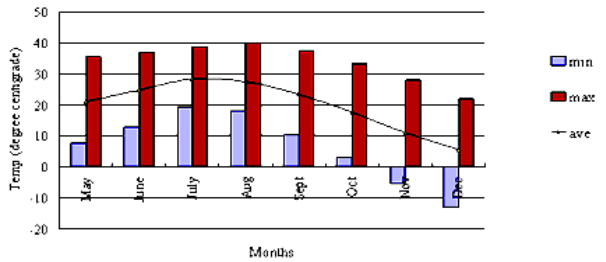

Figure 3. Minimum, Maximum and average temperature during different month

For feasible tillering, as compared to June and September months July and August are the best one but the minimum as well as mean temperature of July is better than August, not only quality but the duration also affected by the change of temperature (Fig. 3). Rice yield depends upon the number of tillers per unit area [24]. Higher temperature has positive effect on tillers while low temperature has negative. Like; at 23ºC temperature during of tillering period is eight weeks whereas at 27ºC temperature it reduced to five weeks. While 27ºC is also suitable for maximum number tillerings per unit area [25 & 26].

Consequently in reproductive and ripening phases still need higher temperatures about at least 15ºC during reproductive and 23ºC during ripening phases. These are the reasons which insist to cultivate rice as early as possible to get maximum benefit of temperate timings. In our case it is quite difficult to get the ideal temperature during ripening phase but if the direct seeding rice sowed in 2nd week of May or transplantation in 2nd week of June then it will be the best.

Authors [8, 27, 28, 29, 30 & 31] observed that low temperature affects the pencile initiation, number of florets and generation of pencile tips. For japonica varieties it is 15ºC temperatures while for Indica it is below 20ºC. Temperature effects on delay in flowering, partial fertility and low fertilization owing to inhibition of anther dehiscence [31].

Researcher [32] observed that the length of the ripening phase was traditional and was characterized by a growing degree-day of 825 accumulated over a base temperature of 0ºC. The work of [33] shows that inspite of temperatures in the ripening phase varying from 24ºC in the rainy season to 31ºC, the duration of the phase was constant at about 29 days across varieties and seasons. Optimum night temperature for this phase is thought to be 23ºC [34] and minimum temperature in the 30-day period following flowering is viewed as an important yield-determining factor [35].

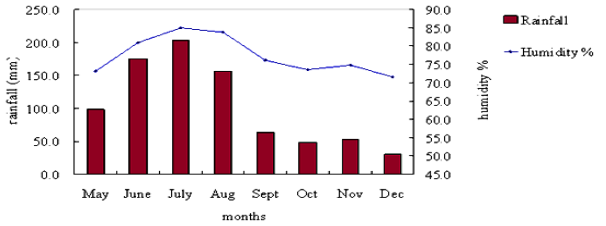

Figure 4. Humidity % and Rainfall (mm) during different months

Humidity and use of maximum rainfall also suits the rice cultivated in start of May and harvested late September or early October (Fig. 4). Researcher [36], stated that flowering is affected by below 40 per cent relative humidity, while 70 to 80 percent RH is the best. Even 60 percent RH effects the leaves of the rice crop [37]. Due to more relative humidity widened the stomata opening that results more photosynthesis [37].

CONCLUSSION AND RECOMMENDATIONS

It was observed that the temperature has an increasing trend while the humidity and wind speed have decreasing trend; whereas rainfall and sunshine hrs didn't have any particular trend. This is also observed that change in climate looks better for rice crop. It is concluded that 2nd week of May is best for nursery growth or directed sowing of rice, whereas 2nd week of June is best for transplantation.

A close eye should be kept on weather parameters and planning must be carried out accordingly to get maximum benefit from it.

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