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Effect of sowing environment and genotypes on medium duration rice under south alluvial zones of Bihar

Birendra Kumar[1*], Niru Kumari[1], Shashank Tyagi[1] and Amarendra Kumar[2]
[1]Department of Agronomy
[2]Department of Plant pathology
Bihar Agricultural University, Sabour, Bhagalpur-813210
*Corresponding author e-mail: *agrobacbr76@rediffmail.com*

ABSTRACT
A field experiment was conducted during Kharif season of 2012 and 2013 at Bihar Agricultural University, Sabour on medium loam soil under aerobic situation to study the effect of sowing environment and genotypes on medium duration rice under south alluvial zones of Bihar. The experiment was laid out in Split Plots design with eighteen treatments having three replications. Six rice genotypes viz. Prabhat, Sushksamrat, MTU1010, MTU1001, PHB71 and A6444 were grown under aerobic conditions with three dates of sowing viz. 10 June, 20 June and 30 June. The results revealed that accumulated heat units and yield decreased with delayed in sowing time till crop reached tillering stage and increased thereafter till crop physiological maturity. Aerobic rice sown on10th June utilized more thermal and heat units as compared to 20th June and 30th June sown crop. The grain yield was higher when maximum temperature (T_{max}) during heading phase remained between 32.4 and 32.8^0 C and decreased considerably when T_{max} was above 33.5^0 C during this phase . The total grain yield declines by 4.31 q ha^{-1} per 1^{0}C rise in T_{max} during heading stage due to reduction in 'pollen viability', resulting in greater spikelet sterility and consequently lower grain yield. Daily bright sunshine hours (BSH) of 7 to 8 hours during flowering stage led to enhanced grain yield. However, BSH of less than 7 hours resulted in decline of grain yield. Correlation studies indicated significant positive correlation was recorded between bright sunshine hours and grain yield of aerobic rice.
***Key words**: Genotypes, grain yield, growing degree days, rice, weather parameters*

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INTRODUCTION

Rice productivity largely affected by set of climatic variables like rainfall, temperature and solar radiation etc. play a significant role for potential yield. The responses and requirements of these variables which determine the growth and development of a plant in a given environment may vary from variety to variety with in a species. In the same variety, they may also very from one growth stage to another. The final biomass and yield of crops depend on the integrated effects of stages. Phonological development is the most important attribute involved in crop adaptation to varied growing environments. The crop duration under different dates of sowing of rice are greatly influenced by temperature and may be estimated by accumulated heat unit [1]. Kharif season length and the relative duration of key phenophases, are critical determinants of grain yield in field crops.

In Bihar rice crop is grown on an area of about 3.3 million hectares, producing 6.8 million tons with an average productivity of 2.1 tons per hectare [2]. There is a wide gap between average productivity and potential productivity owing to environmental factors, technology adoption and timely availability of inputs [3]. Thus, to understand the crop phenology-weather interaction and to enhance the rice productivity in the highly dense populated state Bihar, the knowledge of the duration of different developmental phases and their association with yield determining weather factors is essential. With the help of crop weather relation studies, it is possible to show as to how the changes in rainfall amount, solar radiation and temperature during different growth stages influence the crop productivity. Many researchers have studied crop weather relations and developed location specific regression models using weather variables for predication of yields of rice [4] and [5]. However, a very few information is available at present. In view of above, an attempt has been made here to assess the impact of weather variables prevailing during different phenology phases of growth on grain yield and thereby quantify and optimum weather conditions for maximizing the aerobic rice production at Sabour, Bhagalpur under South alluvial zones of Bihar.

MATERIALS AND METHODS

The field experiment was conducted during rainy seasons the (*kharif*) of 2012 and 2013 at Bihar Agricultural University, Sabour, Bihar (25°04′ N latitude, 87°04′ E longitude and 37.19 meter above mean sea levels),in a Split plots design with three replications. The treatments comprised of dates of sowing in Main plot viz. 10 June, 20 June and 30 June whereas Sub plot treatments comprised of varieties viz. Prabhat, Sushksamrat,MTU1010, MTU1001, PHB71 and A6444.The experimental soil was sandy loam in texture having the pH 7.3. The organic carbon, electrical conductivity, available nitrogen, phosphorus and potash were 0.49%, 0.106 ds/m, 251.3, 25.41 and 189.36 kg/ha, respectively.

Rice was sown at 20 cm apart in rows in 10 cm plant to plant distance in the first fortnight of June, depending upon the onset of monsoon, during the two years. The crop was fertilized with 80, 40, 20 kg ha^{-1} of N, P_2O_5 and K_2O, respectively in the forms of urea, single superphosphate and muriate of potash, respectively. In rice, half recommended dose of N (40 kg ha^{-1}) and full dose of P_2O_5 and K_2O was applied at sowing while the remaining nitrogen (40kg ha^{-1}) was applied in two splits dose, half at active tillering and the rest half at panicle initiation stage. All the other recommended agronomic and plant protection measures were adopted to raise the crop. The occurrence of phonological events like tillering, heading, flowering, milking, dough and maturity were recorded from each plot and average dates of these phases were calculated and used for analysis.

Table1: Various Phenological phases and GDD requirements under different sowing dates of *kharif* aerobic rice

date of sowing	Tillering	Heading	flowering days after sowing	Milking	Dough	Maturity
10 June	48	79	91	101	112	127
20 June	47	76	87	98	109	125
30 June	45	75	86	97	108	120
			GDD(^{0}Cday)			
10 June	1040	1686	1937	2149	2368	2662
20 June	1015	1612	1846	2073	2289	2580
30 June	970	1596	1824	2040	2252	2453

The daily weather data on maximum, minimum temperature and sunshine hours for the growing seasons were collected from the nearby agrometeorological observatory, Bihar Agricultural University Sabour. Optimum weather conditions in terms of mean and ranges of maximum temperature (T_{max}), minimum temperature(T_{min}) and bright sunshine hours (BSH) during different crop growth phases were worked out based on daily weather observations. The accumulated growing degree day (GDD) or heat units were worked out for different phases of growth using the following equation:

GDD = $[(T_{max} + T_{min})/2\text{-}Tb]$

Where, T_{max} = Maximum temperature of the day in $^0{}_C$HHH

T_{max} = Minimum temperature of the day in $^0{}_C$HHH

T_b = Base temperature in $^0{}_C$

In the present study, T_b considered was 8 $^0{}_C$. Simple correlation coefficients were computed between rice yield and weather parameters [6].

RESULTS AND DISCUSSION

The duration of various phonological phases of aerobic rice on two consequent crop seasons observations presented in the (Table1) revealed that there was a lot of variation in days required to attain different phases when the crop is grown under different micro-environmental conditions. The first two dates of sowing could be considered as normal sowing date for aerobic rice in this region, whereas 30 June represents late sowing of the aerobic rice. The result revealed that there was a decrease in duration of different growth phases with delay in sowing of aerobic rice. The crop sown on 30 June required 3 days less to attain maximum tillering stage than that sown on 10 June. However, the duration required to attain 50% flowering in 10 June and 20 June sown crop were 91 and 87 days, respectively. The crop sown on 10 June crop may attained maturity in 127 days, while crop sown on 30 June reached maturity in 120 days. [7] reported that higher air temperature and incident radiation tend to advance anthesis in rice.

Such variation in durations of different phenophases of the rice crop may have been due to changes of sowing dates, which led to early or delayed fulfillment of thermal requirements to attain a particular phenophase. While considering the accumulated GDD (Table 1) required for reaching different phenophases, it was observed that similar pattern like that of phenophase durations was noticed in all phenophases.

Table 2: Correlation coefficients of weather variables at different phonological phases with grain yield of aerobic rice. HHH

Weather paramenters	Tillering	Heading	Flowering	Milking	Dough	Maturity
Tmax	0.17	-0.56**	0.77**	0.13	0.07	0.02
Tmin	0.26	-0.13	0.16	-0.03	-0.12	-0.14
Tmean	0.13	0.08	0.27	0.47*	0.63	0.55**
BSH	-0.08	-0.37	0.83**	0.14	0.12	0.38

The accumulated GDD to reach tillering decreased with delay in sowing, whereas, the accumulated GDD for attaining other growth phases also decreased. As compared to 10 June sown aerobic rice crop to the 30 June sown crop availed of more GDD for attaining 50% flowering stage and the respective GDD were 1937, 1846 and 1824 ^{0}C days respectively. At maturity, the accumulated GDD were 2662, 2580 and 2453 ^{0}C days for 10 June, 20 June and 30 June sown aerobic rice crops, respectively. The days to attain tillering, heading, flowering and maturity demonstrated higher positive correlation coefficients, ranging from 0.77 to 0.83, with their corresponding GDD requirements, and thus indicating the dependence of phasic thermal time requirements on phenophase durations. Requirement of higher thermal time in early sown aerobic rice crop for completion of heading corroborates the previous work of [8] in transplanted rice. The 10 June sown crop in present study availed more time of hot summer months than did 30 June sown crop and hence accumulated more thermal time.
HHH

Crop-weather relations

The performance of a crop is at the mercy of mainly on the growing season, prevailing weather conditions and the genetic make-up of any crop species. Hence, identification of critical weather variables and their quantification at different growth phases is prerequisite for successful crop production in a region. Correlation coefficients (Table 2) between weather parameters at different phenophases of aerobic rice and grain yield indicated that there was a significant positive correlation of T_{max} with grain yield during flowering, correlation of negative correlation during heading phase. Except at tillering and flowering phases, T_{min} showed negative correlation with grain yield. The BSH exhibited significant positive correlation with grain yield establishing thereby that light plays an important role in the growth and yield of rice during flowering phase. The significant positive association of T_{mean} at milking, dough and maturity phases with grain yield was observed; demonstrating thereby that higher, T_{mean} led to enhanced grain yield. HHH

The relationship of mean BSH during flowering stage and , T_{max} during heading and flowering stages with grain yield of aerobic rice have been presented in (Table 2) . The relationship between grain yield and BSH indicated that mean BSH during flowering stage showed positive linear relationship with grain yield, ascribing to increasing grain yield with lengthening BSH. The rate of increase of grain yield per 1 hour rise in sunshine during flowering phase was 2.7 q ha^{-1}. [9] reported that the number of tillers and ears (panicles) increased with the intensity and quantity of light. In the present study, BSH during flowering to maturity phases demonstrated positive correlation with grain yield (Table 2.), leading to the fact that higher values of BSH prevailing during anthesis to maturity augmented the grain yield and its attributes. [10] observed significant positive correlation between solar radiation during panicle initiation to crop maturity and grain yield of rice. [11] observed that more sunshine at the time of panicle emergence to fertilization leads to greater yield. It was noted that grain yield was higher at mean BSG between 7 to 8 hours during flowering stage, while yield decreased with BSH of less than 7 hours during this growth stage.

CONCLUSIONS

Crops weather relationship studies brought out several critical information, which could be useful in achieving attainable yield of aerobic rice under south alluvial zones of Bihar. Higher grain yield was observed at T_{max} between 32.4 and 32.8^{0}C during heading while grain yield reduced appreciable when

T_{max}>33.5 ^{0}C was recorded during this phase, Daily bright sunshine hour (BSH) of 7 to 8 hours was found to enhance the rice grain yield, while the yield decreased at BSH of less than 7 hour during flowering stage. Weather during flowering of the crop played most important role by exercising its impact on grain yield of aerobic rice.

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