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CROP WEATHER RELATIONSHIPS ON AEROBIC RICE PRODUCTION UNDER COASTAL AREA

[1]S. Pazhanisamy, [2]AL. Narayanan, [3]V. Sridevi and [4]Rodda Chandana Devi

[1]Ph.D. Research Scholar, [2]Professor, [3]Asstt. Professor, [4]Ph.D. Research Scholar

[1]Department of Agronomy,

[1]Dr.Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar-848 125 India.

Abstract: A field experiment was conducted during *Navarai* season from February to June, 2017 at Agronomy farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute Karaikal, Union Territory of Puducherry, India to study the crop weather relationships on yield of aerobic rice under coastal region. The treatment consisted of three different date of sowing by weekly interval (February 6th, February 13th and February 20th) with five different seed priming practices. The treatments were evaluated in factorial concept of RBD with replication thrice. The results indicated that with respect to date of sowing, seeds sown on 6th February produced significantly the highest grain yield (2591.5 kg ha^{-1}). This was followed by 13th February and 20th February of 1977.7 and 1236.8 kg ha^{-1}, respectively. Correlation studies showed that the total bright sunshine hours did not significantly influenced the grain yield. However the mean maximum temperature, mean minimum temperature, total rainfall and total evaporation had a significant effect on grain yield. Regarding stepwise regression equations between grain yield of rice and weather parameters revealed that mean maximum temperature, mean morning relative humidity, mean evening relative humidity, total rainfall, total sunshine hours and total evaporation contributed to an extent of 90.5 per cent for total life span. From the study proved that the early sowing window February 6th to be more effective for influencing for higher productivity during *Navarai* season under aerobic rice cultivation at the coastal deltaic region.

Key words: Date of sowing, Aerobic rice, Direct weather parameters, Correlation and Regression.

I. INTRODUCTION

Rice is the stable food of over half of the world population and most of the Asian countries (Dileep *et al.*, 2018). This is unique among the major cereals by virtue of its extent and adaptability to wider range of edaphic, climatic and cultural conditions. Considered the abiotic stresses, weather plays the dominant role in influencing the growth and yield of rice (Islam *et al.*, 2018). India has the largest rice area with 43.79 million hectares, it stands second after China with respect to production (116.42 million tonnes) and an average productivity of 25.78 q/ha^{-1} (Directorate of Economics & Statistics, Ministry of agriculture, 2019). In India rice crop is largely dependent on monsoonal rains. Rice consumes 30 per cent of all fresh water used worldwide and 80% in India (Pazhanisamy *et al*., 2020). The productivity of Asian irrigated rice system is increasingly threatened by water scarcity. Tuong and Bouman (2003) estimated that by 2025, 2 million ha of Asian irrigated dry season rice and 13 million ha of its irrigated wet season rice may experience "physical water scarcity". Which the regions facing water scarcity, the aerobic rice system is proving to be a promising technology by reducing water use (Bouman *et al.*, 2007). Aerobic rice is refers to growing rice in condition of non-flooded and non-puddled low land soil with supplemental irrigation. Aerobic rice recorded substantial water savings by minimizing seepage, percolation and greatly reduced evaporation (Bouman *et al.*, 2005). Aerobic rice generally requires 30 to 50 per cent less water even though, it resulted in a yield penalty of 20 to 30 per cent (Yang *et al.*, 2005). Rice production in the tropics is sensitive to weather which affects the crop in various ways during different stages of its growth and certain stages are more sensitive to weather than others (Wassmann *et al.*, 2009). The potential productivity of the aerobic rice could be positively changed by altering the sowing window in tune with favorable weather. Hence by keeping these views an experiment was conducted to study the crop weather relationships on yield of aerobic rice under coastal region.

II. METHODOLOGY

A field experiment was conducted at Agronomy eastern farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry, India during *Navarai* season (February to June, 2017). It is situated at 10^o 55' N latitude and 79^o 49 ' E longitude with an altitude of 4 meters above Mean Sea Level (MSL). Karaikal is a tropical climate and receives the normal rainfall of 1397 mm in a year with an average maximum and minimum temperatures of 35.4 and 25.6^{o}C respectively. The normal relative humidity was 87.9 and 59.9 per cent. The soil of the experimental site was clayey having normal i.e., pH -7.1 ,EC - 0.1 dSm^{-1},organic carbon -0.60 %, low available N -191.29 kg ha^{-1}, high available P -163.00 kg ha^{-1} and normal K -279.6 kg ha $^{-1}$. The experiment was laid out in the Randomized Block Design (Factorial) with three replication and the treatments combination consist of three date of sowing at weekly intervals *viz*., 6th February (S_1), 13th February (S_2), and 20th February, (S_3) with five seed priming practice *viz.*, P_1: Water P_2: KCl (1%) P_3: Moringa leaf extract (2%) P_4: Pungam leaf extract (1%) P_5: Fresh cow dung solution (5%). Rice variety PMK (R) 3 seeds were sown in line manually with 20 x 10 cm spacing in the well prepared field. Irrigation was immediately given after sowing. Later, the number of lifesaving irrigation was given when, hair line cracks were formed. Recommended fertilizer (150:50:50 NPK) doses was applied in splits (Phosphorus as basal, nitrogen and potassium at 15 DAS, tillering phase (35 DAS), panicle initiation (55 DAS) and flowering phase (75 DAS) equally). Additionally, $ZnSO_4$ was applied @ 25 kg ha^{-1} at tillering phase (35 DAS) and panicle initiation phase (55 DAS). Biometric observations were recorded as per the guidelines of All India Coordinated Rice Improvement Project (AICRIP), Hyderabad. In each plot, five hills were selected and tagged at random in the net plot area for recording the biometric observations at various growth phases *viz*., vegetative, reproductive, maturity phase and the yield attributes were recorded at the time of harvest.

Meteorological data were recorded from the meteorological observatory of Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA&RI), Karaikal for various phenophases of the respective treatments to study their influence on aerobic rice.

Correlation and regression analysis: The data collected on various crop growth phases were correlated with weather parameters at seedling, vegetative, reproductive and maturity phases so as to establish the relationship by using't' test. The significant relationship was further regressed using the stepwise regression to arrive at valid regression equation by using SPSS software.

III. RESULT AND DISCUSSION

3.1. Effect of weather parameters on grain yield of aerobic rice

Grain yield which is the ultimate economic yield is a function of integrated expression of many physiological process involved in the growth and development of the crop. In general, among the date of sowing early sowing date of 6th February recorded a grain yield of 2592 kg ha^{-1} (Table 1), which is about 63.3 per cent higher than the later date of sowing 20th February (1236.84 kg ha^{-1}). The success of aerobic rice mainly depends on time of sowing. The potential yield of rice crop can be achieved only by growing at its appropriate sowing window in a cropping season (Singh *et al*., 1990). Egli (1998) was explained about that low temperature increases the grain yield by delaying the grain maturation and extending the grain filling. High temperature reduces grain yield by reducing the percentage of ripened grains. Also, Jana *et al.* (2013) reported that higher temperature during the flowering period results in poor seed setting and causes spikelet sterility reducing the yield. Later sowing had high temperature when compared to its earlier sowing which may have resulted in the reduced grain yield by increasing the spikelet sterility. Haridassan (2006) opined that the grain yield of rice increases with increasing trend of radiation and lesser temperature during reproductive phase. Low diurnal variation and less relative temperature disparity produced increased fertility coefficient in rice it was reported by Ramanadane (2003).

Table. 1. Effect of Date of sowing and Seed priming practices on grain yield of rice

Date of Sowing (S)	P_1: Water	P_2: 1% KCl	P_3: 2% Moringa leaf extract	P_4: 1% Pungam leaf extract	P_5: 5% Cow dung slurry	Mean
			Seed Priming (P)			
S_1: 6th February	2316.9	2370.3	3033.9	2637.3	2599.2	2591.52
S_2: 13th February	1847.8	1878.3	2379.9	1947.9	1834.5	1977.68
S_3: 20th February	1010.7	1264.3	1355.8	1151.8	1401.6	1236.84
Mean	1725.13	1837.63	2256.53	1912.33	1945.1	1935.35
			S Ed	**CD (p= 0.05)**		
		S	52.32	107.17		
		P	67.54	138.36		
		S x P	116.99	239.65		

3.2. Correlation and Regression between weather parameters and yield of aerobic rice

Correlation studies resulted that the total bright sunshine hours did not significantly influenced the grain yield. However the mean maximum temperature, mean minimum temperature, total rainfall and total evaporation had a significant negative effect on grain yield, but the other two weather parameters of Mean Relative humidity Morning and Mean Relative humidity evening showed a significant positive effect on the grain yield (Table 2).

Table. 2. Correlation coefficients between weather parameters and rice yield during different phenophases of aerobic rice

Sl. No	Weather parameters	Seedling phase	Vegetative phase	Reproductive Phase	Total life span
1	Mean maximum temperature	-0.929**	-0.957**	-0.939**	-0.939**
2	Mean minimum temperature	-0.955**	-0.094 NS	-0.955**	-0.934**
3	Total rainfall	-0.805**	0.805**	-	-0.836**
4	Mean Relative humidity Morning	-0.919**	0.912**	0.944**	0.934**
5	Mean Relative humidity evening	-0.943**	0.955**	0.844**	0.922**
6	Total bright sunshine hours	0.591*	-0.854**	-0.365 NS	0.104 NS
7	Total evaporation	0.370 NS	-0.885**	-0.814**	-0.876**

*Significant at 5% level, ** Significant at 1% level, NS: Non Significant

Stepwise regression equations between grain yield of rice and weather parameters revealed that mean maximum temperature, mean morning relative humidity, mean evening relative humidity, total rainfall, total sunshine hours and total evaporation contributed to an extent of 90.5 per cent for total life span. During vegetative and reproductive phases all the weather parameters contributed significantly to an extent of 95.2 per cent and 96 per cent respectively, but seedling phase all the weather parameters exception mean minimum temperature and mean morning relative humidity contributed significantly to an extent of 96.5 per cent (Table 3). That could be justified for increase in relative humidity during active tillering phase increased the number of panicles per hill. High relative humidity with high solar radiation positively influence the number of leaves per plant as reported by Sridevi and Chellamuthu (2015). Raju and Narayanan (2017) opined that the weather parameters such as temperature, morning and evening relative humidity were contributing to greater extent for the production of higher grain yield than the other parameters.

Table 3. Step wise regression equation for rice grain yield and weather parameters

Sl.No.	Regression equation	Phase	R^2	Level of significance
1	Y=43591.23+ 80.98Tmax -21.0RF –419.81RH1-9.076BSSH -28.69EVP	**Seedling**	0.965	1%
2	Y= -80534.80 +1901.75T max – 2803.63Tmin –15.68RF +512.86RH1+599.40RH2 – 57.87 BSSH + 112.18EVP	**Vegetative**	0.952	1%
3	Y= 13642.15+ 9.48Tmax – 552.26Tmin +75.14RH1 -110.46 RH2 +7.63BSSH -28.67EVP	**Reproductive**	0.960	1%
4	Y= 56465.95 -1442.02Tmax+15.322 RF -1585.23RH1+ 2348.92RH2+ 12.87BSS-23.09EVP	**Total lifespan**	0.905	1%

Y = Expected DMP/grain yield (kg ha^{-1})
Tmax : Maximum Temperature
Tmin : Minimum Temperature
RF : Total Rainfall
RH1 : Morning Relative Humidity
RH2 : Evening Relative Humidity
BSSH : Bright Sun Shine Hours
EVP : Evaporation

CONCLUSION

The study proved that during *Navarai* season early sowing date of 6th February was provide the higher productivity and an opportunity to mitigate the untoward incidence of drought under aerobic rice cultivation in the coastal area.

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