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Influence of weather parameters on yield of lowland rice (*Oryza sativa* L.)

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ABSTRACT

Field experiments were conducted during *kharif* and *rabi* seasons of 1998 and 1999 to study the influence of weather parameters on grain yield of low land rice. Correlation studies revealed that grain yield was positively correlated with accumulated growing degree days in reproductive phase during *kharif* and bright sunshine hours during all the three phenophases of rice during *rabi*. An accumulated growing degree days of 422°C day and 9.9 hours of daily mean bright sunshine during *kharif* and *rabi* seasons, respectively are required for optimum grain yield of lowland rice.

Keywords : AGDD, bright sunshine hours, grain yield

Agriculture and climate are closely linked in the crop growth, development and production, and affected by both long term meteorological factors (the climate) and short term meteorological events (the weather). The major limiting factors for higher productivity are sunlight and temperature. The light and temperature combination play an important role in rice production since the light intensity requirement for rice is higher and temperature dependent (Venkataraman, 1987). Sunlight in addition to furnishing energy, also plays an important role in regulating flowering and maturation of rice plants. Temperature influences crop growth through processes such as photosynthesis and maintenance respiration. Seshu and Cady (1984) carried out a statistical analysis of weather data and yield; and developed a regression equation for the relationship between rice yield and, radiation and temperature. Crop weather models have become key to predict grain yield in a vast country like India for planners and policy makers. Variety of models were developed to predict yields in different crops. Parthasarathy *et al*., (1998) have developed prediction equation based on regression model, for total Indian food grain production using monsoon rainfall. The forecast equations have also been

Table 1 : Sowing and planting dates of rice during *kharif* and *rabi* seasons during 1998 and 1999

Kharif		*Rabi*	
Date of sowing	Date of planting	Date of sowing	Date of planting
D_1 = 17.06.98	D_1 = 15.07.98	D_1 = 07.11.98	D_1 = 16.12.98
D_2 = 01.07.98	D_2 = 01.08.98	D_2 = 23.11.98	D_2 = 04.01.99
D_3 = 15.07.98	D_3 = 22.08.98	D_3 = 10.12.98	D_3 = 23.01.99
D_4 = 16.6.99	D_4 = 15.7.99	D_4 = 12.11.99	D_4 = 30.12.99
D_5 = 03.07.99	D_5 = 01.08.99	D_5 = 06.12.99	D_5 = 09.01.2000
D_6 = 16.07.99	D_6 = 13.08.99	D_6 = 30.12.99	D_6 = 03.02.2000

developed for predicting paddy yield (Shanker and Gupta, 1987 and 1988). The present study was undertaken to assess the influence of various weather parameters on grain yield of rice and to develop yield prediction model with minimum set of weather variables for lowland rice.

MATERIALS AND METHODS

Field investigations were carried out during *kharif* and *rabi* seasons of 1998 and 1999 at Agricultural Research Institute Farm, Rajendranagar, Hyderabad to study the influence of weather parameters during different phenophases of rice on final grain yield. Data were subjected to statistical analysis by taking years as main plots and date of planting as subplot in each season replicated thrice and a short duration *cv.* Tellahamsa was used in the study. Treatment details are given in Table 1. Entire crop growth period was divided into three distinct phenophases

P_1 = Planting to panicle initiation (Vegetative phase);

P_2 = Panicle initiation to 50% flowering (Reproductive phase) and

P_3 = 50% flowering to physiological maturity (Ripening phase).

Data of weather parameters were

Table 2: Grain yield (kg ha^{-1}) of rice *cv.* Tellahamsa during different date of planting and season

Treatment	*kharif*		*rabi*	
D_1	5083		9136	
D_2	3216		9683	
D_3	2780		10370	
D_4	6202		6144	
D_5	5408		5756	
D_6	3693		59521	
Difference between	S.Em+	CD (p=0.05)	S.Em+	CD (p=0.05)
Years (Y)	225	969	110	472
Dates of planting (D)	172	397	176	405
Interaction (Y x D)	244	561	249	-

recorded from Agrometeorological observatory which is near to experimental site. Accumulated growing degree days were calculated using 10°C as base temperature (Reddy *et al.*, 2004) for each season in both the years for all the three phenophases for use in correlation studies. Finally a linear regression model was fitted for each season to predict grain yield using stepwise regression analysis.

A constant set of package of practices were adopted during both the years of study by leaving weather as only variable.

RESULTS AND DISCUSSION

Significant differences in grain yield was observed between years and among dates of planting during both *kharif* and *rabi* seasons. During *kharif* season, significantly highest grain yield of 5702 kg ha^{-1} was obtained during 1999 compared to the year 1998 (3693 kg ha^{-1}) (Table 1). Among dates of planting, higher grain yield was obtained when crop was planted on 15th July (D_1) and progressive decrease in grain yield was recorded with delay in plantings. The interaction effect of years and dates of planting on grain yield of rice during *kharif* revealed that, significantly highest grain yield was obtained when crop was planted on 15.07.99 (D_1) followed by 01.08.99 (D_2). The highest grain yield with D_1 planting was mainly due to optimum accumulated growing degree days of 422°C day during reproductive phase and either increase or decrease in AGDD resulted in reduction in grain yield (Table 3).

During *rabi* season, significantly higher grain yield of 9730 kg ha^{-1} was during the year 1998 over 1999 (Table 2). Among the dates of planting, significantly highest grain yield was obtained during third date of planting i.e., last week of January to first week of February (D_1 and D_2). The early plantings resulted in significantly lower grain yield of rice during *rabi* season. The highest grain yield of 10370 kg ha^{-1} was obtained when crop was planted on 23.01.99 (D_3) and it was mainly due to more number of bright sunshine hours and decrease in sunshine hours from 9.9 to 9.4 hours per day resulted in reduced grain yield (Table 3).

Correlation studies between grain yield and daily mean weather variables during different phenophases revealed that, the significant positive correlation (r = 0.89**) existed between grain yield and accumulated growing degree days during reproductive phase of rice during *kharif* season. Grain yield increased with increase in number of AGDD during reproductive phase and maximum yield

Table 3: Accumulated growing degree days during *kharif* and bright sunshine hours during *rabi* in reproductive phase of rice in 1998 and 1999

Date of planting	*Kharif*		*Rabi*	
	AGDD	Calender days	BSS	Calender days
D_1	392	24	9.9	30
D_2	309	19	9.8	25
D_3	352	22	9.9	24
D_4	422	25	9.4	24
D_5	413	25	9.5	25
D_6	429	24	9.5	22

Table 4: Observed and predicted grain yield (kg ha^{-1}) of rice *cv*. Tellahamsa during *kharif* and *rabi* season of 1998 and 1999

Date of planting	*Kharif*			*Rabi*		
	Observed	Predicted	% Error	Observed	Predicted	% Error
D_1	5084	4851	4.8	9236	9954	-7.2
D_2	3216	2678	20.1	9684	9062	6.9
D_3	2780	3804	-26.9	10370	9954	4.2
D_4	6202	5636	10.0	6144	5492	11.9
D_5	5496	5401	1.8	5847	6384	-8.4
D_6	5408	5820	-7.1	5952	6384	-6.8

was obtained at 422 degree days and further increase in AGDD decreased grain yield during *kharif* season. The higher AGDD was due to increased number of calender days during reproductive phase. Increase in duration of reproductive phase from 19 to 25 days under different dates of planting might have increased the size of sink during *kharif* season. During *rabi* season, significant correlation existed between grain yield and daily mean bright sunshine hours during all the three phenophases *viz*., vegetative ($r=0.93^{**}$), reproductive ($r=0.95^{**}$) and ripening phase ($r=0.84^{**}$) of the crop. Krishna Kumar and Subramanian (1991) reported that the yield attributes and yield had positive correlation with solar energy source during reproductive and ripening phases. More sunshine hours during reproductive and ripening phases might have helped in translocation of photosynthates to sink. Moomow *et al.*, (1967) demonstrated close correlation between grain yield and hours of sunshine during ripening phase.

Using stepwise regression analysis, the following yield prediction models were developed to predict the grain yield during *kharif* and *rabi* seasons separately.

Kharif

$Y = 26.182\,X - 5412.8$ ($R^2=0.79$)

Where,

Y = Grain yield (kg ha^{-1})

X = Accumulated growing degree days during reproductive phase

Rabi

$Y = 8925.1 X - 78404$ (R^2=0.91)

Where,

Y = Grain yield (kg ha^{-1})

X = Daily mean bright sunshine hours during reproductive phase

During *kharif* season, the model accounted for 79 per cent variation in the grain yield with accumulated growing degree days during reproductive phase, while in *rabi*, model accounted for 91 per cent variation in the grain yield with daily mean bright sunshine hours during reproductive phase.

The observed and predicted grain yield of rice and per cent error in yield obtained by the models are presented in Table 4. The per cent error in grain yield ranged from –26.9 to 20.1 per cent and –8.4 to 11.9 per cent during *kharif* and *rabi* seasons, respectively. The lower yield of 2780 kg ha^{-1} in D_3 planting during *kharif* 1998 was due to continuous heavy down pour of 80.4 mm occurred in single day prior to 5 days of 50 per cent heading. In D_2 planting also the heavy down pour of 101.4 mm occurred in a single day prior to 4 days of 50 per cent heading. This heavy rainfall might have washed away the pollen resulting in reduced yields.

It may be concluded that, an accumulated growing degree days of 422°C day and 9.9 hours of bright sunshine during reproductive phase for *kharif* and *rabi* seasons, respectively were optimum for realizing higher grain yield in short duration *cv.* Tellahamsa.

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