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Influence of low temperatures stress on growth and yield of rice

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ABSTRACT

A field experiment was conducted during two consecutive seasons of *Kharif* 2003 and 2004 at Regional Agricultural Research Station, Jagtial to study the influence of low temperature stress on phenology and yield of *Kharif* rice. Results indicated that grain yield was significantly higher with early sowing followed by normal sowing. Among varieties JGL 1798, which is a short duration variety, recorded the highest grain yield followed by JGL 384.The long duration variety BPT 5204 produced significantly higher yield under early sown conditions and the grain yield progressively declined as the sowings were delayed. The minimum temperatures at flowering was strongly and positively correlated to yield as compared to minimum temperatures from PI to 50% flowering and 50% flowering to maturity. The regression equation indicated reduction in grain yield by 654 kg/ha due to one-degree reduction in minimum temperature at the time of flowering.

Key words : Dates of sowing, Grain yield, Phenology, Varieties, Rice, Low temperature stress

INTRODUCTION

Rice is the principal crop in the Northern Telanagana region of Andhra Pradesh during *Kharif*. Due to erratic monsoon conditions coupled with lack of inflows into reservoirs, delay in transplanting of *Kharif* rice even beyond September is quite a common phenomenon. Drastic reduction in grain yields were observed due to delayed plantings. Further, the late-planted crop here suffers due to higher incidence of pests and diseases resulting in poor yields (Rao, 1991). The major production factor, to boost the yields of high yielding varieties of rice are optimum sowing time and improved package of practices. Temperature is one of the major factor influencing crop growth, which can not be manipulated under field conditions, but seeding time can be adjusted in a particular region to fit the existing temperature regimes best suited for different growth stages (Kumar *et al.,* 1998). Hence, a field experiment was conducted to find out the suitable variety and cut off date of sowing to escape temperatures stress in the Northern Telangana zone of Andhra Pradesh during *Kharif*.

MATERIALS AND METHODS

A field experiment was conducted during two consecutive seasons of *Kharif* 2003 and 2004 at Regional Agricultural Research Station, Jagtial. The soil was shallow medium black with pH 7.9, EC 0.42 m mhos/cm and medium in organic carbon, low in available P and high in available K. The experiment was laid out in split plot design with three varieties of different duration (JGL-1798, JGL- 384 and BPT-5204) as main plots and four dates of sowings (25th May, 15th June 10th July and 2nd August) as subplots with three replications. 30-day-old seedlings were planted at a spacing of 20 cm x 15 cm. The crop received a uniform dose of 100 kg N, 60 kg P_2O_5 and 40 kg K_2O /ha. Entire P_2O_5 and half the recommended potash was applied as basal and remaining half potash was applied at panicle initiation stage. Nitrogen was applied in three equal splits 1/3 as basal, 1/3 at active tillering and remaining 1/3 at PI stage. The crop was maintained free from major incidence of insect pests and diseases; shallow submergence condition was maintained until 10 days before harvest. Observations on phenological data, yield attributes and yield were recorded and analysed statitically.

RESULTS AND DISCUSSION

The results obtained from the present study as well as relevant discussion have been presented under following heads:

Dates of sowing:

Data on crop phenology (Table 1) reveals that early sowing took significantly more number of days to attain the stage of 50% flowering followed by very late sowing. The days to maturity were more in early sowing.

Observations on yield attributes reveal that the number of panicles/m^2 and number of filled grains/panicle were higher with early sowing and progressively declined as the date of sowing was delayed. The grain yield was significantly higher with early sowing (5612 and 5461 kg/ha during 2003 and 2004, respectively) as compared to normal, late and very late sowing. Higher grain yield in early date was due to more no of filled grains and higher panicle number.

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Table 1 : Effect of dates of sowing and variety on phenology and yield of rice

Treatments	Days to 50% flowering		Days to Maturity		No. of panicles /m^2		No. of filled grains /panicle		Grain yield (kg/ha)	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Dates of sowing										
27th May	112	113	254	244	239	236	142	142	5612	5461
17th Jun	104	104	233	236	208	209	138	139	4482	4448
10th Jul	107	106	215	209	214	188	137	138	5093	3926
2nd Aug	108	108	187	179	186	149	141	146	3689	2540
CV%	1.2	1.2	6.4	5.1	7.2	7.0	0.4	0.8	8.9%	6.5%
S.E.±	0.42	0.16	4.9	3.8	5.3	4.8	0.20	0.39	150	96.3
C.D. (P=0.05)	1.5	0.55	17.0	13.0	18.3	16.8	0.70	1.35	521	332.0
Varieties										
BPT 5204	116	115	230	224	173	157	149	150	4236	3781
JGL 384	107	108	222	206	224	217	139	141	4780	4132
JGL 1798	100	101	216	210	238	218	131	133	5141	4369
CV %	0.68	0.64	4.8	5.4	8.6	7.2	0.53	0.60	8.8%	8.7%
S.E.±	0.20	0.20	3.2	3.4	5.5	4.3	0.21	0.24	128.8	112.7
C.D. (P=0.05)	0.62	0.59	9.6	10.3	18.2	12.7	0.36	0.73	386.2	338.2
DXV			-	-	-	-			772	676.0

Varieties:

The number of panicles/m^2 were more (Table 1) in long duration variety as compared to short duration variety, where as the trend was just opposite in case of number of filled grains per panicle, where short duration variety recorded the more number of filled grains per panicle. The variety JGL 1798, a short duration variety, recorded the highest grain yield (5141 kg/ha, 4369 kg/ha during 2003, 2004, respectively). The per cent yield increase of JGL 1798 over that of JGL 384 and BPT 5204 varieties was 7.0% and 17.6% higher during 2003 and 5.4%, 13.4% higher during 2004, respectively.

Interaction effect:

Studies on interaction effect (Table 2) reveal that during both the years BPT 5204 resulted significantly higher grain yield (5670 and 5361 kg/ha) during early sowing and the grain yield was progressive declined as the sowing delayed. The lowest grain yield (3191 kg/ha and 1491 kg/ha) was recorded under very late sowing. The per cent yield reduction was 44.0%, 72.0% under very late sowing as compared early sowing during 2003 and 2004, respectively. The drastic yield reduction under very late sowing is mainly due to prevailing of low temperatures (below 14^{0}C) during flowering for a period of 25 days. The minimum temperature is less than 14^{0}C at the meiotic stage of the pollen mother cells causes very high sterility, which in turn adversely effects grain yield in rice (Satake, 1969 and Venkataraman, 1986). Long duration verities transplanted late suffers due to low temperatures less than 15^{0}C at flowering resulting in poor panicle exertion and high sterility as well as low yields (Yoshida, 1988). Where as the yield reduction was not remarkable in JGL 1798 and JGL 384 under late sown conditions as these varieties exposed to temperature less than 14^{0}C for less than a week during flowering and

Table 2 : Interaction effect of dates of sowing and varieties on grain yield of rice

Dates/ varieties	BPT 5204		JGL 384		JGL 1798		Mean	
	2003	2004	2003	2004	2003	2004	2003	2004
27th May	5670	5361	5633	5355	5633	5668	5612	5461
17th June	4307	4378	4829	4057	4829	4910	4482	4448
10th July	3779	3896	4803	4062	4803	3820	5093	3926
2nd August	3191	1491	3853	3053	3853	3077	3689	2540
Mean	4236	3781	4780	4132	4780	4369		

	CV	S.E.±	C.D. (P=0.05)
2003	8.8	257	772
2004	6.8	225	676

escaped from low temperature stress.

Correlation and regression studies:

The correlation studies (Table 3) between minimum temperatures prevailed during different stages and grain yield reveals that among different stages minimum temperatures at flowering was strongly positively correlated with yield as compared to minimum temperatures from panicle initiation to 50% flowering and 50% flowering to maturity. Among different varieties the long duration variety BPT 5204 was more prone to minimum temperature stress compared to JGL 384 and JGL 1798 as it shown very strong and positive correlation with grain yield and minimum temperatures prevailed during flowering (r=0.99).

Table 3 : Relationship ('r' values) between minimum temperatures at different stages of crop growth and grain yield (pooled analysis of 2003 and 2004)

Independent variable	BPT 5204	JGL-384	JGL-1798
Minimum temperature from PI to 50% flowering	0.93**	0.84**	0.87**
Minimum temperatures during flowering	0.99**	0.93**	0.72*
Minimum temperatures from 50% flowering to maturity	0.96**	0.90**	0.80*

* and ** indicate significance of values at P=0.05 and 0.01, respectively

The multiple linear regression interaction of minimum temperatures and yield data for BPT 5204, 98.0% of the yield variation in dependent variable was explained by the independent variables X1, X2, X3 and R^2 was found to be highly significant. For unit change in X2 keeping X1 and X2 constant Y will change by the quantity of 654 kgs (Table 4). Similarly for JGL 384 the R2 was found to be significant (0.73). For unit change in X2 keeping X1 and X2 constant Y will change by the quantity of 0.22 kgs. Where as in JGL 1798 the R^2 was found to be not significant.

Table 4 : Multiple linear regression interaction of minimum temperatures on yield of rice

	Equations fitted	
Variety	Equation	R^2 Value
BPT-5204	Y= - 420 + -230 X1+654 X2+ -197 X3	R^2 = 0.98
JGL-384	Y= 1612 + -51 X1+0.22 X2+ 206 X3	R^2 = 0.73
JGL-1798	Y= -1082 + 283 X1+-334 X2+ 300 X3	R^2 = 0.46

X1 = Minimum temperature from PI to 50% flowering
X2 = Minimum temperatures during flowering
X3 = Minimum temperatures from 50% flowering

Conclusion:

The results indicates that under late sown conditions *i.e.* sowing in August 1st week and planting beyond September it is advisable to go for short and medium duration varieties rather than long duration varieties especially in Telangana region of Andhra Pradesh. Irrespective of the duration of the varieties, sowing on or before 1st Fortnight of July is advisable for getting reasonably higher yields.

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