Validation of CERES and WOFOST models for prediction of phenology and yield of rice in Telangana region of Andhra Pradesh

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INTRODUCTION

- Rice is an important crop grown in an area of 3.5 -4.0 million ha. In A.P.
- It is grown under diverse agro climatic conditions
- There is a need to have an advance estimates of production for better planning
- Simulation models are the tools available for identifying critical constraints and also for advance prediction of the yields

OBJECTIVES

- To develop genetic coefficients and conversion coefficients of rice for CERES and WOFOST models
- To calibrate and validate CERES and WOFOST models for rice in Telangana region of Andhra Pradesh

Methodology

Kharif 2004

Location – RARS, Jagtial, Karimnagar

Variety - JGL 1798

Dates of sowing – D1: 26.05.2004

D2: 16.06.2004

D3: 11.07.2004

D4: 04.08.2004

Observations - Phenology and yield recorded

Methodology (Contd..)

Kharif 2005

Location – RARS, Jagtial, Karimnagar

Variety - : JGL 1798 MTU 1010

Dates of sowing : 04.07.2005 03.07.2005

Observations : Phenology and yield recorded

Methodology (Contd..)

Kharif 2006

Location – ARI, Rajendranagar, Hyderabad

Varieties - : JGL 1798 & MTU 1010

Dates of planting : 31.07.2006 & 11.08.2006

Observations - Phenology and yield recorded

Models tested : CERES & WOFOST

Sensitivity analysis was done for different dates of sowing

Genetic coefficients used in the CERES-Rice model

Name	Description	Genetic coffecients		
		JGL 1798	MTU 1010	JGL384
P1	Time period during juvenile stage.	480	480	560
P2O	Critical photoperiod.	170	165	180
P2R	Extent to which phasic development leading to panicle initiation is delayed for increase in photoperiod above P20.	350	350	430
P5	Time period start of grain filling to PM	11	11	12
G1	Potential spikelet number coefficient at anthesis.	55	55	68
(G2)	Single grain weight- under non stress conditions	0.013	0.020	0.0135
(G3)	Tillering coefficient	1	1	1.1
(G4)	Temperature tolerance coefficient.	1	1	1.17

Genetic/ conversion coefficients for WOFOST medel

Growth stage	Coefficient	MTU1010	JGL1798	JGL384
	Temperature sum from emergence to anthesis	1700	1750	1924
	Temperature sum from anthesis to maturity	500	466	479
	Max. relative increase in LAI	0.006	0.005	0.005
0.0	Specific leaf area	0.005	0.005	0.005
1.0		0.0029	0.0019	0.0017
2.0		0.0029	0.0017	0.0014
0.65	Extinction coefficient for diffuse light	0.4	0.4	0.4
1.0		0.7	0.7	0.6
2.0		0.8	0.8	0.6

Contd..

Growth stage	Coefficient	MTU1010	JGL1798	JGL384
0.0	Max.leaf CO2 assimilation rate	40	40	40
1.0		40	40	40
2.0		40	40	40
	Efficiency of conversion into leaves	0.754	0.7540	0.854
	Efficiency of conversion into storage organs	0.720	0.600	0.684
	Efficiency of conversion into rootss	0.754	0.754	0.754
	Efficiency of conversion into stems	0.754	0.754	0.854

Comparison of rice phenology and yield (kg ha^{-1}) predicted by CERES-Rice model with the observed values during *kharif* -2004 at Jagtial

Variety	Date of sowing	50% Flowering (DAP)			Physiological maturity (DAP)			Yield (kg ha^{-1})		
		Obs	Pred	Error %	Obs	Pred	Error %	Obs	Pred	Error %
JGL 1798	26.05.04	74	75	1.4	106	100	-5.7	5658	5807	2.6
	16.06.04	74	75	1.4	101	101	0.0	4909	5639	14.9
	11.07.04	69	68	-1.5	99	97	-2.0	3832	5515	43.9
	04.08.04	70	67	-4.3	104	99	-4.8	2751	5634	104.8

Comparison of rice phenology and yield (kg ha^{-1}) predicted by CERES-Rice model with the observed values during kharif - 2005 at Jagtial

Variety	Date of sowing	50% Flowering (DAP)			Physiological maturity (DAP)			Yield (kg ha^{-1})		
		Obs	Pred	Error %	Obs	Pred	Error %	Obs	Pred	Error %
JGL 1798	04.07.05	58	65	12.1	90	97	7.8	5140	5351	4.1
MTU 1010	03.07.05	55	53	-3.6	85	81	-4.7	7300	7342	0.6

Simulated LAI, yield and HI of rice cv. MTU 1010 estimated under different dates of transplanting using CERES model at RARS, Jagtial

Time of planting	Days to Heading	Days to Maturity	Yield Kg ha^{-1}
10-Jul	64	90	7288
20-Jul	64	90	7111
30-Jul	61	88	7313
10-Aug	59	87	7551
20-Aug	55	86	7273
30-Aug	56	89	7016

Simulated LAI, yield and HI of rice cv. JGL 1798 estimated under different dates of transplanting using CERES model at RARS, Jagtial

Time of planting	Days to Heading	Days to Maturity	Yield Kg ha^{-1}
10-Jul	77	104	5377
20-Jul	75	102	5362
30-Jul	73	103	5565
10-Aug	70	102	5368
20-Aug	70	105	5644
30-Aug	69	107	5583

Simulated LAI, yield and HI of rice cv. JGL 1798 estimated under different dates of transplanting using WOFOST model at RARS, Jagtial

Date of transplanting	Max. LAI		Grain yield (t ha^{-1})		Biomass (t ha^{-1})		Harvest index(%)	
	2004	2005	2004	2005	2004	2005	2004	2005
10-July	4.49	4.17	4.49	4.45	8.63	8.37	52.0	53.0
20- July	4.35	4.10	4.29	4.45	8.55	8.38	50.0	53.0
30- July	4.23	3.89	4.52	4.40	8.69	8.33	52.0	53.0
10-August	4.18	4.27	5.04	4.48	9.19	8.57	55.0	52.0
20- August	4.21	4.35	5.16	5.54	9.45	9.84	55.0	56.0
30- August	4.69	4.09	4.95	6.26	9.63	10.58	51.0	59.0

Simulated LAI, yield and HI of rice cv. MTU 1010 estimated under different dates of transplanting using WOFOST model at RARS, Jagtial

Date of transplanting	Max. LAI		Grain yield (t ha^{-1})		Biomass (t ha^{-1})		Harvest index(%)	
	2004	2005	2004	2005	2004	2005	2004	2005
10-July	6.6	6.13	6.65	6.27	12.57	11.91	53.0	53.0
20- July	6.54	6.14	6.25	6.47	12.35	12.20	51.0	53.0
30- July	6.24	5.98	6.55	6.38	12.54	12.08	52.0	53.0
10-August	6.32	6.24	7.09	6.66	13.04	12.51	54.0	53.0
20- August	6.32	6.6	7.41	7.71	13.51	13.85	55.0	56.0
30- August	6.6	6.29	6.84	8.65	13.28	14.72	51.0	59.0

Comparison of grain yield (t/ha) simulated by CERES and WOFOST models at RARS, Jagtial

Date of transplanting	JGL 1798		MTU 1010	
	CERES	WOFOST	CERES	WOFOST
10-July	5.38	4.45	7.29	6.27
20- July	5.36	4.45	7.11	6.47
30- July	5.56	4.40	7.31	6.38
10-August	5.37	4.48	7.55	6.66
20- August	5.64	5.54	7.27	7.71
30- August	5.58	6.26	7.02	8.65

Validation of CERES Rice for phenology and yield of JGL 384 at Rajendranagar during 2006

Phenology / yield	31-Jul			11-Aug		
	Observed	Predicted	% Dev.	Observed	Predicted	% Dev.
Heading	84	74	-11.9	81	72	-11.1
Maturity	129	110	-14.7	115	109	-5.2
Yield (kg/ha)	6539	6764	3.4	6931	6696	-3.4

Validation of CERES Rice for phenology and yield of MTU 1010 at Rajendranagar during 2006

Phenology / yield	31-Jul			11-Aug		
	Observed	Predicted	% Dev.	Observed	Predicted	% Dev.
Heading	68	66	-2.9	63	65	3.2
Maturity	102	96	-5.9	95	100	5.3
Yield (kg/ha)	5382	7922	47.2	6697	8010	19.6

Validation of WOFOST for phenology and yield of JGL 384 at Rajendranagar during 2006

Phenology / yield	31-Jul			11-Aug		
	Observed	Predicted	% Dev.	Observed	Predicted	% Dev.
Heading	84	77	-8.3	81	77	-4.9
Maturity	129	107	-17.1	115	108	-6.1
Yield (kg/ha)	6539	6664	1.9	6931	6803	-1.8

Validation of WOFOST for phenology and yield of MTU 1010 at Rajendranagar during 2006

Phenology / yield	31-Jul			11-Aug		
	Observed	Predicted	% Dev.	Observed	Predicted	% Dev.
Heading	68	64	-5.9	63	64	1.6
Maturity	102	90	-11.8	95	91	-4.2
Yield (kg/ha)	5382	7547	40.2	6697	7377	10.2

Sensitivity analysis of CERES Rice *cv.* MTU 1010 for phenology under different dates of planting

Time of planting	Age of seedlings (Days)	Days to Heading (Days)	Days to Maturity (Days)
10-Jul	30	67	98
20-Jul	30	68	99
30-Jul	30	76	97
10-Aug	30	64	98
20-Aug	30	63	98
30-Aug	30	63	99

Sensitivity analysis of CERES Rice *cv.* JGL 384 for phenology under different dates of planting

Time of planting	Age of seedlings (Days)	Days to Heading (Days)	Days to Maturity (Days)
10-Jul	30	75	109
20-Jul	30	75	109
30-Jul	30	74	110
10-Aug	30	72	109
20-Aug	30	71	109
30-Aug	30	70	110

Sensitivity analysis of WOFOST *cv.* JGL 384 for phenology under different dates of planting

Time of planting	Age of seedlings (Days)	Days to Heading (Days)	Days to Maturity (Days)
10-Jul	30	75	102
20-Jul	30	77	105
30-Jul	30	77	107
10-Aug	30	77	109
20-Aug	30	79	111
30-Aug	30	82	117

Sensitivity analysis of WOFOST *cv.* MTU 1010 for phenology under different dates of planting

Time of planting	Age of seedlings (Days)	Days to Heading (Days)	Days to Maturity (Days)
10-Jul	30	62	88
20-Jul	30	63	89
30-Jul	30	64	90
10-Aug	30	64	91
20-Aug	30	64	94
30-Aug	30	66	96

Comparision of grain yield of rice predicted by CERES and WOFOST models at Rajendranagar

Date of planting	MTU 1010		JGL384	
	CERES	WOFOST	CERES	WOFOST
10-Jul	8287	7156	6618	6309
20-Jul	8188	7262	6570	6559
30-Jul	7914	7581	6756	6630
10-Aug	8268	7377	6802	6995
20-Aug	8075	7895	6675	7178
30-Aug	8084	7970	6305	8090

Conclusions

- Genetic coefficients were developed for the rice cultivars JGL 1798, JGL 384 and MTU 1010.
- CERES and WOFOST models have performed well in predicting both for phenology and yield at both the locations.
- Model simulations commensurate with the experimental results with respect to time of planting in North Telangana Agroclimatic Zone i.e.,
  - Medium duration – first fortnight of August
  - Short duration - Second fortnight of August
- WOFOST model needs further refinement for South Telangana Agro climatic zone

Future line of work

- CERES and WOFOST models need be tested for other popular cultivars of the region *vis a vis* other regions of the State for prediction of phenology and yield

- These models need to be validated for Nitrogen management

Thank You