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Validation of CERES - rice model for prediction of upland rice yield*

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ABSTRACT

In the present investigation CERES-rice model was validated to predict the development, yield attributes and yield of upland rice cv. Pant Dhan-4 transplanted on three dates during *kharif* seasons of 1997 and 1998 at Pantnagar (Lat. 29o N, Long. 79o 30' E and at an elevation of 243.84 m above mean sea level). The results showed that simulated and observed values of days taken to panicle initiation and 50 per cent flowering were predicted well (r =0.717 and 0.945, respectively), but days taken to maturity were over estimated during both the years. There were high correlations between observed and simulated values of yield attributes including number of panicles m^{-2} (r =0.972), number of grains $panicle^{-1}$ (r =0.660) and 1000-grain weight (r=0.983); and yield (r =0.935). The results indicate that CERES-rice model can be considered as a good tool for prediction of development, yield attributes and yield of upland rice.

Key words : CERES - rice model, upland rice

Contributing consistently to around 45 per cent of India's cereal, rice continues to hold the key to sustained food sufficiency in the country (Siddiq, 1999). Further increase in rice production with limited land resources is possible only by optimization of management practices using modern technologies. Optimization of planting date is directly related to the crop production because it not only enhances the tiller number but also the total grain production (Dhiman *et al.*, 1997). Efforts have also been made by various researchers in India and abroad to maximize rice yield, using various combinations of inputs under different transplanting dates of rice in varying soil and climatic conditions (Ding and Chai, 1982 and Reddy *et al*, 1984). In recent years dynamic crop simulation models (Godwin and Vlek, 1985; Jones and Kiniry, 1984; Boote *et al.*, 1988 and Chipanshi *et al.*, 1997) have been found most useful to predict the phenology and yield by using a minimum data set.

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Present investigations were carried out for two years (1997 and 1998) to optimize the transplanting date and validate the CERES-Rice model for upland rice grown under tarai conditions of Uttaranchal

MATERIALS AND METHODS

Field experiments were conducted during *kharif* seasons of 1997 and 1998 at Crop Research Center of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar having humid sub-tropical climate with average annual rainfall of 1433.4 mm. The experiments were laid out in randomized block design with three planting date treatments viz. 15 June (D1), 01 July (D2) and 15 July (D3), and each replicated thrice with high yielding rice cv. Pant Dhan-4 under upland condition. The optimum soil moisture was maintained by applying 7.5 cm irrigation water 3 days after disappearance of ponded water in addition to rainwater received during both the seasons. The soil classified as Patherchatta sandy loam (Deshpande *et al.*, 1971) is moderately to well drained Typic Hapludoll associated with 2.5 m water table from the surface. All the recommended agronomic practices were adopted to raise the crop except operations under the treatment. Standard procedures were followed to study the growth, development and yield of the crop. The simulation study was carried out using CERES-rice model (Tsuji *et al.*, 1994) to predict the phenology, yield and yield attributes of the. To validate the model comparison between simulated and recorded values were made using standard statistical procedures.

RESULTS AND DISCUSSION

Phenological studies

Phenology of rice crop was studied in terms of leaf area index (LAI); days taken to panicle initiation (PI), 50 per cent flowering and maturity stages of the crop. Observed values of LAI were maximum (4.94 and 4.80) in 1 July transplanted (D2) crop (Table 1) followed by D1 and D3 treatments at 50% flowering stage, while, the simulated values were 7.30 and 8.27, 7.03 and 7.90, and 5.39 and 7.39, respectively. The results showed that simulated values were higher than those observed at tillering, panicle initiation and 50 per cent flowering stages but at maturity stage simulated values were lower than the observed values of LAI during both the years. It may be dut to assumption of faster rate of leaf senescence in the model. Overall LAI was reasonably simulated as the co-efficient of determination (r^2) for observed and simulated LAI at different phenological stages were 0.85 and 0.81 in D_1, 0.87 and 0.79 in D_2, and 0.69 and 0.65 in D_3 treatments during 1997 and

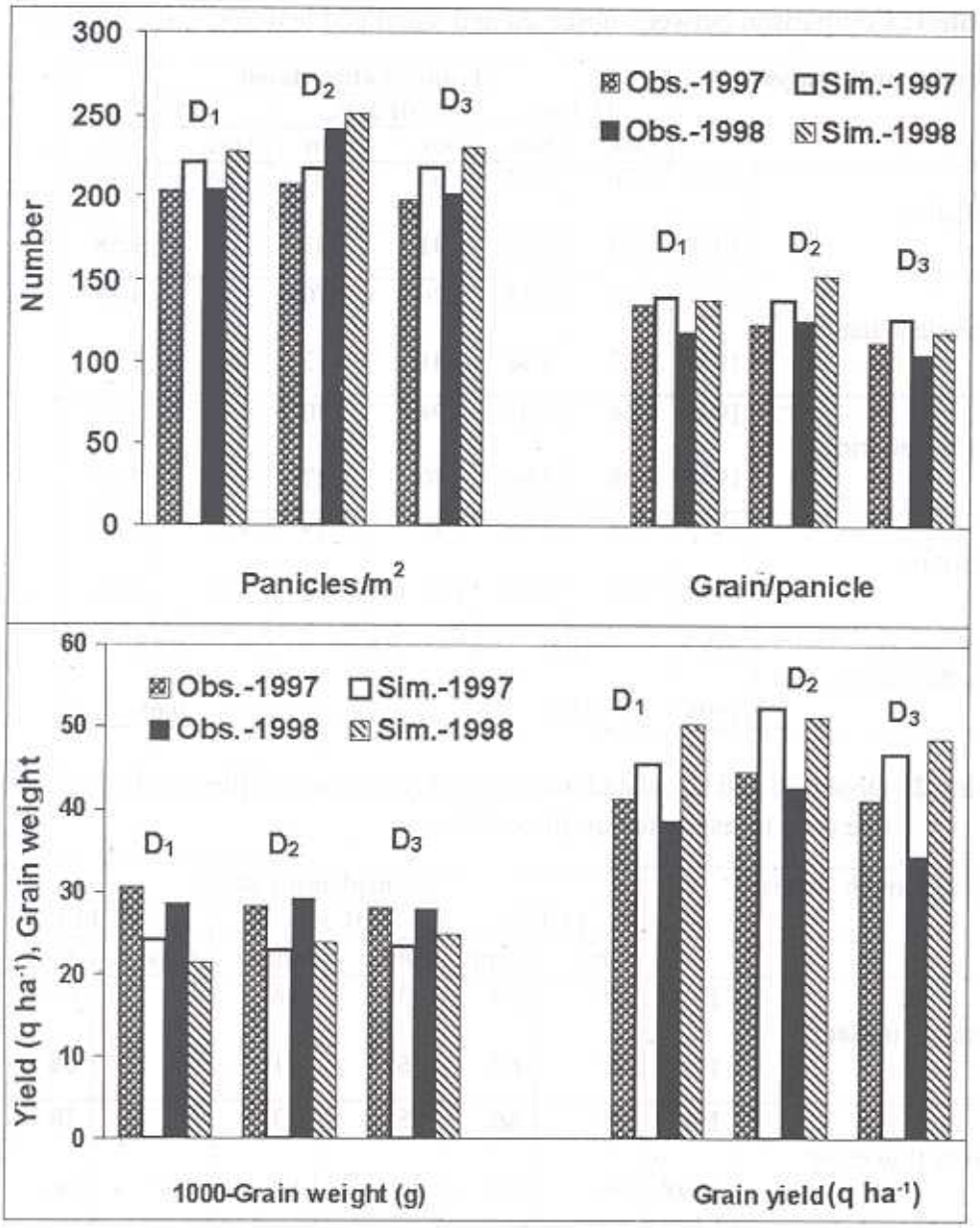

Fig. 1: Observed and simulated number of panicle m^{-2} and number of grains $panicle^{-1}$ 1000-grain weight and grain yield of rice crop transplanted on three dates.

Table 1: Comparison between observed and simulated leaf area index (LAI).

Crop growth stages		Transplanting dated					
		15 June		01 July		15 July	
		Obs.	Sim.	Obs.	Sim.	Obs.	Sim.
Tillering	1997	1.76	1.83	1.67	1.84	1.65	2.33
	1998	1.28	1.73	1.31	1.63	1.30	1.58
Panicle initiation	1997	3.22	3.65	3.26	3.70	3.27	4.35
	1998	3.27	4.68	3.31	4.13	3.26	2.75
50 % flowering	1997	4.56	7.03	4.94	7.30	4.41	5.39
	1998	4.48	7.90	4.80	8.27	3.78	7.39
Maturity	1997	3.23	2.72	3.31	2.79	3.27	2.60
	1998	3.20	2.95	3.31	2.68	3.25	2.36
Correlation coefficient (r)	1997	0.85		0.87		0.69	
	1998	0.81		0.79		0.65	

Table 2: Observed and simulated number of days taken to different phenophases of rice crop transplanted on three dates.

Crop growth stages		Transplanting dates					
		15 June		01 July		15 July	
		Obs.	Sim.	Obs.	Sim.	Obs.	Sim.
Panicle initiation	1997	75	69	73	68	72	66
	1998	77	67	76	71	70	68
50 % flowering	1997	95	86	95	83	79	78
	1998	96	87	94	84	79	76
Maturity	1997	130	127	132	134	128	140
	1998	130	126	130	126	125	130

1998, respectively (Table 1).

The observed and simulated data on days taken to panicle initiation, 50 per cent flowering and physiological maturity of the rice crop are given in (Table 2). The results showed that the number of days taken to panicle initiation were significantly affected by change in transplanting dates during both the years. Observed and simulated days taken to panicle initiation showed an overall correlation of 0.717 in good agreement with the values reported by Mandal and Mahapatra (1968). Number of days taken to 50 per cent flowering was also found to be affected by change in transplanting dates. Due to delay in transplanting from 15 June to 15 July, observed and simulated days taken to 50 per cent flowering decreased from 95.3 to 79.3 and 86.0 to 78.0 days, respectively during 1997, however, these reductions were 95.7 to 79.3 and 87.0 to 76.0 days, respectively during 1998. The statistical analysis of data showed high correlation (r = 0.972) between observed and simulated values of days taken to 50 per cent flowering stage. The observed and simulated number of days taken to maturity of rice (Table 2) reduced by 4 to 5 and 4 to 13 days with delay in transplanting date from 01 July to 15 July.

Yield and yield attributes

The data on yields and yield attributes are depicted in Figures 1-A& B. The results showed that delay in transplanting caused reduction in number of panicles m^{-2}. The data further showed that during 1997 observed and simulated number of panicles m^{-2} were maximum in D_1 (203.3 and 221.0) followed by D_2 (208.3 and 217.0) and D_3 (198.7 and 219.0), respectively, while, during 1998 the above respective values were 205.3 and 228.0, 241.7 and 251.0, and 202.7 and 230.0 in D1, D2 and D3 treatments, respectively. The reduction in number of panicles m^{-2} was 8.7 and 10.4 per cent due to delay in transplanting from 15 June to 01 July and 01 July to 15 July, respectively. Similar reductions due to delay in transplanting from 1 July to 16 July and from 1 July to 16 August, respectively have also been reported by Gangwar and Sharma (1998). Statistically observed and simulated values of number of panicles m^{-2} were highly correlated (r=0.972). The results further showed that number of grains per panicle in D3 were less than those observed and simulated (r =0.66) in D1 and D2 treatments. 1000-grain weight though with correlation of 0.983 was under estimated during both the years in all the treatments. Maximum grain yield (44.59 and 42.69 $q.ha^{-1}$) was recorded in D2 followed by D1 (41.49 and 38.57 $q.ha^{-1}$) and D3 (41.21 and 34.49 $q.ha^{-1}$) treatments during 1997 and 1998 years, respectively and showed a very high

correlation (r = 0.935) between observed and simulated yield.

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