

Evaluation of Oryza Model for Paddy Crop under Different Water Supply Situations in Pusa Condition

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Abstract

An Oryza model for paddy (*Oryza sativa* L.) crop was conducted during 2003 to predict regional yield under different water supply situations in Pusa condition. Three varieties of paddy crops were taken namely, Rajshree, Kanak and Sita for three water supply situations like adequate, limited and rainfed. The model requires three sets of data base, i.e. crop, soil and weather. The crop data included the weight of green leaves, weight of stem, weight of rough rice, weight of root, depth of root penetration. The soil data comprised the information on soil layer their thickness, moisture content, saturated hydraulic conductivity and weather data base consisted of rainfall, humidity, wind speed, altitude, latitude and longitude of place and year in which crop was grown under Pusa condition. The predicted values of Oryza model vary maximum upto 30% as compared to their observed values.

Key words : Oryza model, Adequate, Limited, Rainfed water supplies, Simulation.

Paddy (rice) mostly grown in *khariif* season in an area about 3.58 mha in Bihar and is frequently subjected to moisture stress. Appropriate scheduling of irrigation plays vital role for optimizing the grain yield of rice. Paddy crop is sensitive to moisture stress and the yield is reduced even at - 15 to -20 Kpa metric potential. In spite of water, fertilizer especially nitrogenous fertilizer is essential and largely used to express the yield potential of paddy (rice). Proper management of soil and weather also play the vital role in the yield of paddy.

Methods

The field experiment was undertaken near the shed of Department of Soil and Water Conservation, Rajendra Agricultural University, Bihar, Pusa (Samastipur) during 2003 in *khariif* season. The physico-chemical properties of experimental plot was sandy loam in texture and had pH 8.4, organic carbon (0.31%) and low in available NPK 201.3, 12.3 and 113.8 kg/ha respectively. The field plots were prepared manually and its proper grade was formed to facilitate irrigations. The experiment was conducted in check basin having size 2.25 m × 2 m. The seedlings

of all three varieties, viz., Rajshree, Kanak and Sita raised in separate plots and requisite amounts of irrigation and fertilizer were used. The weeds were removed manually. About 25 days old seedlings were used for transplantation. The row to row and hill to hill spacing were kept as 10 cm. About 1 to 2 seed-

Table 1. Per cent variation between predicted and observed values for different parameters under adequate water supply condition.

Parameters	Variety		
	Rajshree	Kanak	Sita
1. WLVG	17.08	3.94	16.20
2. WST	3.85	29.37	17.50
3. WRT	- 8.99	- 11.08	4.93
4. WRR	20.30	23.20	19.55
5. ZRT	6.67	10.00	6.67
6. LAI at transplantation (DAT)	17.99	16.67	16.67
42	14.98	2.31	16.01
67	29.73	-3.23	33.33
77	11.98	-4.55	2.30
7. NFLV at transplantation (DAT)	0.00	0.00	0.00
42	55.73	54.62	53.85
67	34.25	34.72	33.08
77	-13.58	-10.25	-11.00

Table 2. Per cent variation between predicted and observed values for different parameters under limited water supply condition.

Parameters	Variety		
	Raj-shree	Kanak	Sita
1. WLVG	-9.87	-22.29	-25.00
2. WST	24.28	10.45	9.00
3. WRT	-16.35	-25.24	-28.41
4. WRR	17.80	20.40	19.70
5. ZRT	3.32	3.22	3.22
6. LAI at transplantation (DAT)			
42	16.67	16.67	16.67
67	36.95	46.43	48.21
77	8.81	13.74	7.60
7. NFLV at transplantation (DAT)			
42	0.00	0.00	0.00
67	54.46	43.16	41.94
77	7.69	19.42	15.53
	-50.62	-18.18	22.08

Table 3. Per cent variation between predicted and observed values for different parameters under rainfed condition.

Parameters	Variety		
	Raj-shree	Kanak	Sita
1. WLVG	40.20	27.51	46.74
2. WST	27.40	9.40	17.03
3. WRT	-12.35	-29.50	-40.50
4. WRR	21.50	22.00	17.70
5. ZRT	0.00	0.00	0.00
6. LAI at transplantation (DAT)			
42	16.67	16.67	16.67
67	17.82	14.15	-16.39
77	1.61	4.17	15.94
7. NFLV at transplantation (DAT)			
42	-0.70	55.21	55.11
67	7.40	7.40	7.40
77	47.42	43.15	43.70
	15.93	10.70	33.96
	-21.80	-28.86	4.71

lings were transplanted at each hill and transplantation was done manually. Under adequate water supply condition the plots were kept in submerged condition for which about 5 to 10 cm depth of water was maintained, while in limited water supply, total five irrigations were applied and rainfed condition, it fully dependent upon weather condition after transplantation of seedlings. The fertilizer i.e., N, P and K were applied at the rate of 100 kg/ha N, 50 kg/ha P₂O₅ and 40 kg/ha K₂O to the crop. Its full dose was applied in the treatments of adequate and limited water supply conditions, while about half amount of recommended dose was applied to the rainfed condition.

Views on Oryza Model

The Oryza model Woperies et al. (1996) simulates the growth and development of paddy crop in the situations of potential production and water limitation. To simulate all these production situations in several modules were combined, i.e., modules for above ground crop growth, evapotranspiration, soil-water balance and weather data. Rao and Recs (1990) studied the application of a crop growth by using the simulation model of rice and also for scheduling irrigation in the Kaudulla Irrigation Scheme Area in Sri Lanka. To ease the linkage between these modules they were programmed in Fortran. Fortran simulation environment (FSE) was developed by Van Karolingen

(1995) and especially designed it in the programming of the models that dynamically simulates agro-ecological growth processes such as those of the crops and required daily weather data inputs.

Installation and Running of Oryza Model

The Oryza model was programmed in Compaq visual Fortran (CVF), Version 6.1 on IBM compatible personal computers. The installation and run the said model were done in two ways (i) under CVF, allowing the user to change the program code and to subsequently compile and link the model, (ii) as stand alone executable which allows the user to run the standard version of the model without making changes to the source code. In present case, the model was run as executable described as under.

Model Running as in Executable Form. It follows following steps : Copy the entire Oryza directory with all the directories and the files from the CD-ROM onto the hard disk of computer C : / ORYZA. Remove any "read only" property of the files. Execute the ORYZA-EXE ; upon execution, the ORYZA reads the file COTROL DAT present in the sub-directory and places the output in the same sub-directory. After reading the CONTROL DAT file, it demands TIMER DAT file, ORYZA-WP (crop-data file) and Phil, at different depths DAT (weather data) file. After

running the model, the generated results were stored in RESULT DAT file, which can be explored just by opening it.

Model Validation. The Oryza simulates the water balance and crop growth development of low-land rice under potential and water limited conditions. For which model validation, the field experimental database on crop and soil were collected for three different crop varieties, i.e., Rajshree, Kanak and Sita under three water supply conditions. Under Oryza model the data file on crop was named as ORYZA-WP for soil data it was SOIL-RES and for weather data it was used by the name of Phil-1 in which the term "Phill" indicates the station name and 1 as the station code. An application of crop, soil and weather data in the Oryza-model the result was drawn. About 50 test runs were done and respective results were recorded during model calibration for all three-crop varieties under each situation of water supply. The validity of model was also evaluated by computing the percent variation between observed and predicted values as given below.

$$\left[\frac{O_i - P_i}{O_i} \right] \times 100$$

In the equation O_i and P_i indicated the observed and predicted values of different parameters and i denotes the number of parameters.

Results and Discussion

The Oryza model has been evaluated on the basis of growth parameters of paddy crop at different stages in respect of different varieties used under different water supply situations.

Different parameters namely, weight of green leaves (WLVG), weight of stem (WST), weight of root (WRT), weight of rough rice (WRR), rooting depth (ZRT), leaf area index (LAI) at transplantations, 42, 67 and 77 DAT and nitrogen level in leaf (NELV) at transplantations, 42, 67 and 77 DAT were recorded under different water supply situations which were mentioned and three varieties of paddy crops were also mentioned are given in Tables 1, 2 and 3 respectively.

Under adequate water supply condition, in

Rajshree variety weight of root (WRT), i.e. (–9.00%) and nitrogen levels in leaf (NFLV) at stage 77 DAT, i.e. (–13.58%) were over predicted, maximum variation (30.85%) was found in weight of stem (WST) and minimum variation (6.67%) was found in rooting depth, while in Kanak variety weight of root (WRT), i.e. (–11.08), leaf area index (LAI) at stages 67 and 77 DAT were (–3.23%) and (–4.55%) respectively, nitrogen levels in leaf (NFLV) at stage 77 DAT was found (–10.25%) were over predicted. Maximum variation (29.37%) was found in weight of stem (WST) and minimum variation (2.94%) was found in weight of green leaves (WLVG) and in Sita variety, nitrogen levels in leaf (NFLV) at stage 77 DAT, i.e. (–11.00%) was over predicted and most of parameters predicted higher value than the observed value.

Under limited water supply condition, in Rajshree variety, weight of root (WRT), i.e. (–16.35%), weight of green leaves (WLVG), i.e. (–9.87%) and nitrogen levels in leaf (NFLV) at stage i.e. (–50.62%) were over predicted and remaining parameters were within the limit of model validation, while in Kanak variety, weight of root (WRT), i.e. (–25.24%), weight of green leaves (WLVG), i.e. (–22.90%), leaf area index (LAI) at stage 77 DAT, i.e. (–2.09%) and nitrogen levels in leaf (NFLV) at stage 77 DAT, i.e. (–18.18%) were over predicted and in Sita variety, weight of root (WRT), i.e. (–28.41%), weight of green leaves (WLVG), i.e. (–25.00%), leaf area index (LAI) at stage 77 DAT, i.e. (–1.56%) and nitrogen levels in leaf (NFLV) at stage 77 DAT, i.e. (–22.08%) were over predicted. Maximum variation, i.e. (19.70%) was found in weight of rough rice (WRR) and minimum variation i.e. (3.22%) was found in rooting depth (ZRT). Variation in percentage of remaining parameters were found within the limit.

Under rainfed condition in Rajshree variety, weight of root (WRT), i.e. (–12.35%), leaf area index (LAI) at stage 77 DAT, i.e. (–0.70%) and nitrogen levels in leaf (NFLV) at stage 77 DAT, i.e. (–21.80%) were over predicted, while in Kanak variety, weight of root (WRT), i.e. (–29.50%) and nitrogen levels in leaf (NFLV) at stage 77 DAT i.e. (–28.86%) were over predicted and in Sita variety, weight of root (WRT), i.e. (–40.50%) and leaf area index (LAI) at stage 42

DAT, i.e. (-16.39%) were over predicted and remaining most of parameters of three varieties of paddy crop under this condition were found to be useful for model validation.

In Tables 1, 2 and 3 negative values showed the over predicted values than that of observed values.

Conclusion

Based on the results of other workers on the same field of investigation, the Oryza model predicts the crop growth parameters and yield of the paddy crop for different water supply situations (i.e. adequate, limited and rainfed) and this model can also

facilitate to predict the regional yield of paddy crop, based on growth parameters of the crop.

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