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Assessment of production potential of different rice varieties through DSSAT model for three agro climatic zones of Chhattisgarh

Mukesh Pradhan, Harshana Chandrakar and Ranjit Singh

Abstract
The studies were conducted in Department of Agrometeorology on MTU-1010, Rajeshwari and CG Sugandhit Bhog varieties of rice with 3 dates of sowing (1st June, 15th June and 30th June). For these studies, used long term (1989-2019) daily weather data for 3 districts (Raipur, Ambikapur and Jagdalpur). The result revealed that the duration from anthesis and maturity periods varied considerably in all the varieties under different sowing dates. Duration from sowing to maturity was more in 1st date of sowing as compared to delayed sowing. Highest yield 4877 kg /ha was recorded in Rajeswari at Ambikapur district under D2 (15th June) and lowest 2409 kg/ha was observed in CG Sugandhit Bhog under third date of sowing in Jagdalpur district. This shorting of duration was due to thermal stress at later sowing dates.

Keywords: MTU1010, Rajeswari, CG Sugandhit Bhog, Chhattisgarh, rice crop and production potential

Introduction
Rice is one of the most important food grains produced and consumed all over the world. Similarly, Two thirds of the world's population is living in Asia where rice is the prime source of daily food. More than 70 per cent of the rural households depend on agriculture and allied sectors which provide employment to over 60% of the population. The world's total rice area is 167.2 M ha and production is about 769.6 MT with the productivity of 4.6 t ha^{-1}. Among rice growing countries, India has the largest area and is second in production next to China, where it is grown in an area of 43.7 M ha annually with a production and productivity of 168 MT and 3.8 t ha^{-1} respectively (FAOSTAT, 2017a) and it accounts for 45% of food grain production in the country.

In India rice is grown in 43.86 million ha, area with the production level of 104.80 million tons and the productivity is about 2390 kg/ha (Agriculture statistic at a glance-2015). This crop is the backbone of livelihood for millions of rural household and play vital role in the country food security. Agriculture is an important part of the Indian economy, accounting for roughly 17% of the total GDP.

Chhattisgarh, popularly known as "Rice Bowl of Central India" and the state has about 3.7 million ha under the rice cultivation out of which 70% is under rainfed condition, covering both upland and shallow lowland. The average productivity of rice in the state is 20.5 q /ha (Anon 2017) [1]. The major area of the state belongs to Dry sub-humid climate. The southwest monsoon is the main source of rainfall in the state during kharif-season. The state's average annual rainfall is around 1188 mm and irrigation facility is only about 36% of cropped area during kharif that too protective in nature.

Rice crops are better suited to a wider range of climatic conditions than any other single crop of cereal. As such, from lowlands, floodplains, and deltas to hills and mountains, cultivated lands exist. Rice is vulnerable to change in weather and its cultivation continues to be a risky enterprise under unfavorable environment, despite of advances made in rice production technologies. Rice production is affected by sets of various environmental parameters, including genetic characteristics of crop, soil properties, weather conditions and cultivation practices. The quantity and quality of rice cultivar is mainly dependent upon micro climate of the area conditions such as soil types, Rainfall, solar radiation and temperature etc. Rainfall, temperature and radiation play a major role in deciding crop growth, development and yield levels among the various weather elements. As mentioned by the Intergovernmental Panel on Climate Change (IPCC, 2007), crop yields have declined in many Asian countries, due in part to rising temperatures and extreme weather events.

Climate change and global warming are high likelihood that pose a major problem to agriculture as well as to global food security. Changes in solar radiation, temperature and precipitation would affect the change in crop yields and, thus, the agricultural economy.

Materials and Methods

Input data required to run the crop simulation model (CERES-RICE) of DSSAT V 4.7 includes crop data, daily weather data, soil data and crop specific genetic coefficients. Model were evaluated for three different districts i.e. Raipur (latitude 21º 4′N, longitude 81º39′E), Jagdalpur (latitude 19°05'N, longitude 82°04'E) and Ambikapur (latitude 23°01'N, longitude 83°03'E) with three dates of sowing (D1 01 June, D2 15 June and D3 30 June) and three varieties (MTU1010, Rajeswari, CG Sugandhit Bhog) during Kharif season 2017.

Weather data

The daily weather data of the Year 2019 for 3 districts were collected from Dept of Agrometeorology, College of Agriculture, Raipur (C.G.).

Soil data

Physical and chemical parameters of soil are required. Soil water drainage, field capacity, wilting point, layer wise information on initial soil moisture, organic carbon, pH and soil Texture information for three districts were collected from Department of Agrometeorology, College of Agriculture, Raipur (C.G.).

Genetic coefficient

The genetic co-efficients of different varieties were derived from calibration of model are presented in Table 1.

Result and Discussion

The production potential of different rice varieties viz., MTU1010, Rajeswari, CG Sugandhit Bhog has been worked out using DSSAT (Decision Support System for Agro-technology transfer) model for three districts i.e. Raipur, Ambikapur and Jagdalpur which represent the agro-climatic zones of Chhattisgarh under different dates of sowing i.e., 01/06/2017 (D1), 15/06/2017 (D2) and 30/06/2017 (D3) using the weather data of the year 2017-18. The duration of anthesis, maturity and grain yield have been obtained from the simulation model (Table 2, 3, 4).

Production potential of MTU-1010 under three dates of sowing at different districts of Chhattisgarh

It is evident from data shown in table 4. that days taken for Anthesis of varieties MTU1010 was highest in first planting date i.e. 1st June (D1) in all three Agroclimatic zone (Raipur in the range of 72 to 68, Ambikapur in the range of 81 to 79 and Jagdalpur in the range of 85 to75 and about, the days taken for maturity also falls in the similar fasion.

The outcome of grain yield of MTU1010 indicates that the highest grain yield was recorded in first date of planting in all three centers located in three agro climatic zone followed by second and third date of sowing. Delay sowing reduction in grain yield of MTU1010 **(**Fig: 1) was noticed. The data on says required for anthesis, maturity and grain yield of MTU 1010 for all three Agroclimatic zone i.e. Raipur, Ambikapur and Jagdalpur are presented in table 2.

Production potential of Rajeswari under three dates of sowing at different districts of Chhattisgarh

The data of variety Rajeswari with respect to recorded for all the days to anthesis, Days to maturity & grain yield are presented in table 3.

It can be clearly observed that days taken for Anthesis of varieties Rajeswari was highest in first planting date i.e. 1st June (D1) in all three Agro climatic zone (Raipur in the range of 73 to 69, Ambikapur in the range of 81 to 80 and Jagdalpur in the range of 81 to70). The days taken for maturity of varieties Rajeswari was highest in first planting date i.e. 1st June (D1) in Raipur and Jagdalpur station (Raipur in the range of 102 to 101, and Jagdalpur in the range of 114 to113) while in Ambikapur highest days raised for maturity was in third planting date i.e. 30th June (Ambikapur in the range of 128 to 119).

The outcome of grain yield of Rajeswari indicates that the highest grain yield was recorded in second date of sowing in both centers i.e. Raipur (Raipur in the range of 4275kg/ha to 3313kg/ha) and Ambikapur (Ambikapur in the range of 4877kg/ha to 3722kg/ha) while in Ambikapur highest grain yield was in first planting date i.e. 1st June (Jagdalpur in the range of 3610kg/ha to 3080kg/ha) (Fig 2).

Production potential of CG Sugandhit Bhog under three dates of sowing at different districts of Chhattisgarh

Table 4 indicates that days taken for Anthesis of varieties CG Sugandhit Bhog was highest in first planting date i.e. 1st June (D1) i.e. Raipur and Jagdalpur station (Raipur in the range of 86 to 84, and Jagdalpur in the range of 97 to 94) while in Ambikapur highest in third planting date i.e. 30th June (Ambikapur in the range of 100 to 98). The days taken for maturity of varieties CG Sugandhit Bhog was highest in third planting date i.e. 30th June (D1) in all three Agro climatic zone (Raipur in the range of 111 to110, Ambikapur in the range of 147 to 131 and Jagdalpur in the range of 127 to 124).

The outcome of grain yield of CG Sugandhit Bhog shows that the highest grain yield was obtained in second date of sowing in both the centers i.e. Raipur (Raipur in the range of 4392kg/ha to 2947kg/ha) and Ambikapur (Ambikapur in the range of 4548kg/ha to 2751kg/ha) while in Jagdalpur highest in first planting date i.e. 1st June (Ambikapur in the range of 2673kg/ha to 2409kg/ha) (Fig 3).

Model estimated the days taken to anthesis and maturity among all the dates of sowing and variety. Number of days to attain anthesis and maturity were found to be decreased as the sowing dates were delayed in all the three varieties (MTU1010, Rajeswari and CG Sugandhit Bhog).The analysis found that 3rd date of sowing (30 June) is most vulnerable to possible increase of temperature followed by 2nd (15 June) and 1st date of sowing (1st June). As yield reduction is lowest in 2nd date of sowing (15th June) with all the cultivars (MTU1010, Rajeswari and CG Sugandhit Bhog) in both the station i.e. Raipur & Ambikapur while in Jagdalpur yield reduction was lowest in first (1st June) date of sowing in Chhattisgarh agro-climatic zones. It will be appropriate to go for mid-season (15th June) sowing of rice to minimize climate induced yield loss considering the future scenarios.

Similarly, Dongarwar *et al.* (2005) also reported that early sowing on 15 and 30 June resulted significantly higher grain yield 31.29 and 32.61 q/ha, respectively than late sowing on 15 August (28.40 q/ha)

Table 1: Calibrated Genetic coefficients for three cultivars of rice

Variety	P1	P2O	P2R	P5	G1	G2	G3	G4
MTU-1010	548	246	146	12	49	0.250	1	1
Rajeshwari	522	447	142	11.7	55	0.257	1	1
CG Sugandhit Bhog	741	320	148	11.4	51	0.265	1	1

Table 2: Production Potential of Variety MTU-1010 under three dates of sowing at three districts of Chhattisgarh.

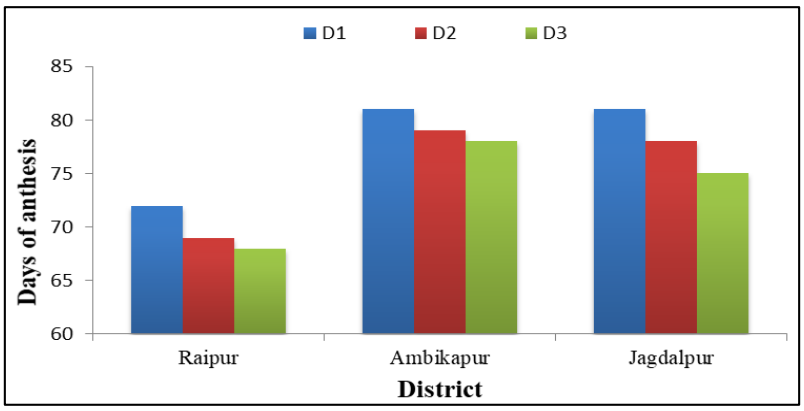
	D1	D2	D3
Station		**Days of Anthesis**	
Raipur	72	69	68
Ambikapur	81	79	79
Jagdalpur	81	78	75
		Days of Maturity	
Raipur	91	89	90
Ambikapur	106	106	109
Jagdalpur	103	100	98
		Grain Yield (Kg/ha)	
Raipur	3212	3326	2667
Ambikapur	3968	3914	3014
Jagdalpur	2889	2455	2554

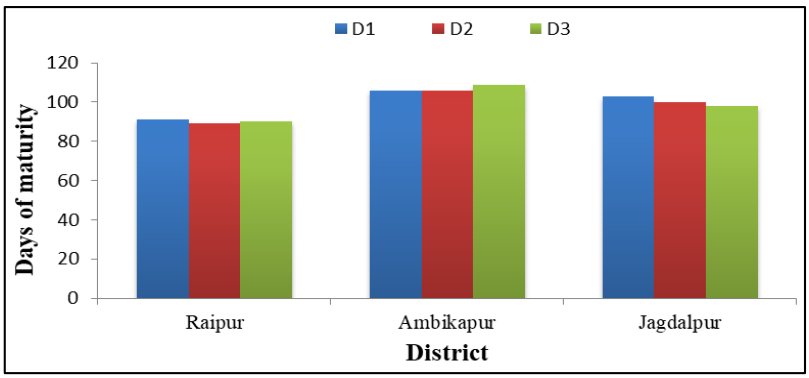
Table 3: Production Potential of Variety Rajeswari under three dates of sowing at three districts of Chhattisgarh.

	D1	D2	D3
Station		**Days of Anthesis**	
Raipur	73	70	69
Ambikapur	81	80	81
Jagdalpur	81	79	77
		Days of Maturity	
Raipur	102	101	101
Ambikapur	119	122	128
Jagdalpur	114	113	114
		Grain Yield (Kg/ha)	
Raipur	4057	4275	3313
Ambikapur	4872	4877	3722
Jagdalpur	3610	3080	3342

Table 4: Production Potential of Variety CG Sugandhit Bhog under three dates of sowing at three districts of Chhattisgarh.

	D1	D2	D3
Station		**Days of Anthesis**	
Raipur	86	85	84
Ambikapur	99	98	100
Jagdalpur	97	95	94
		Days of Maturity	
Raipur	110	111	111
Ambikapur	131	136	147
Jagdalpur	124	124	127
		Grain Yield (Kg/ha)	
Raipur	3881	4392	2947
Ambikapur	4061	4548	2751
Jagdalpur	2673	2603	2409





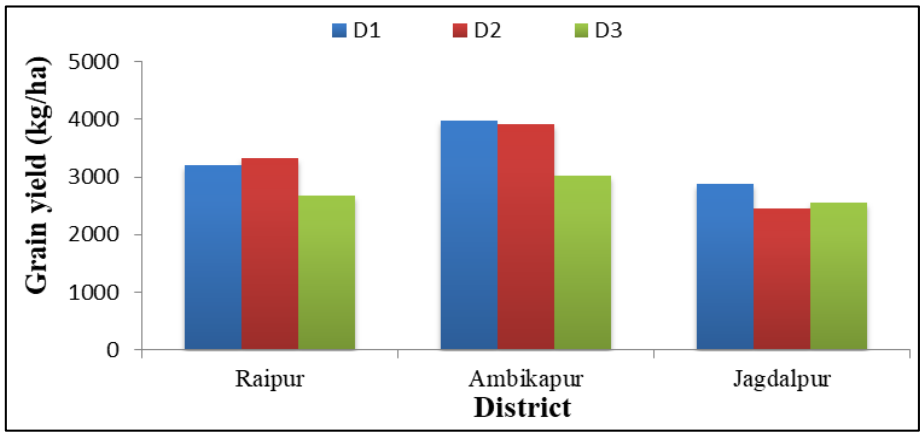
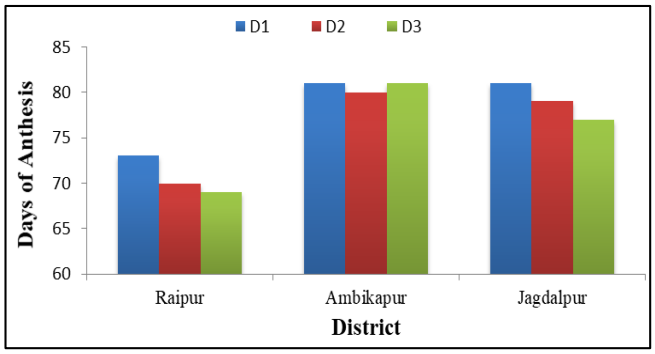
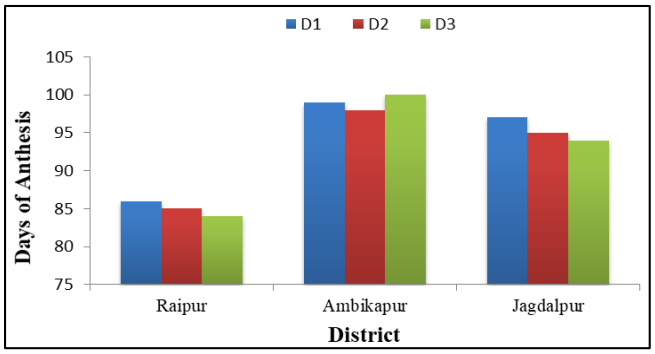
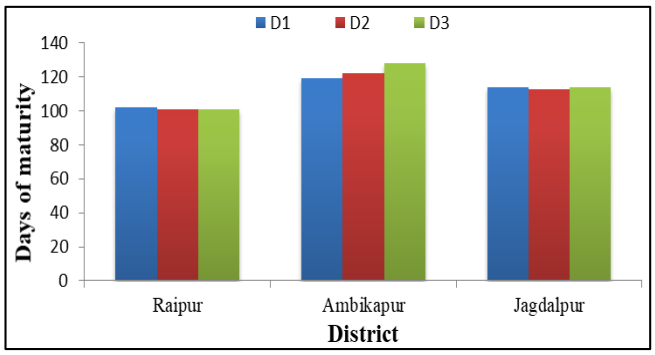
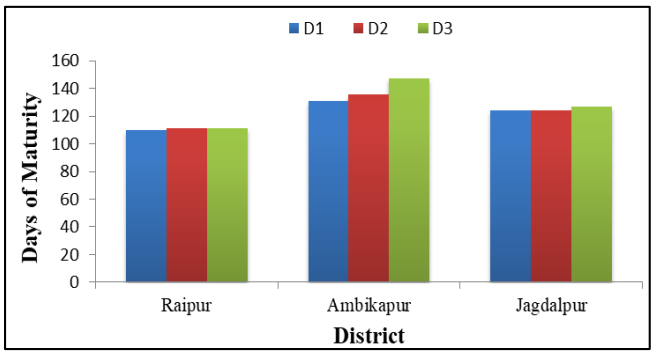


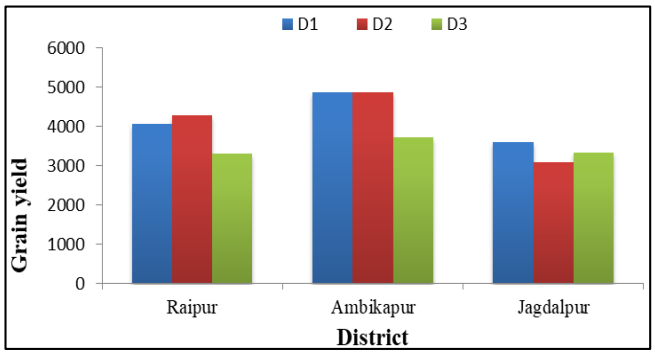
Fig 1: Days of anthesis, maturity and grain yield (kg/ha) of MTU1010 under different dates of sowing (DAS) at different districts of Chhattisgarh











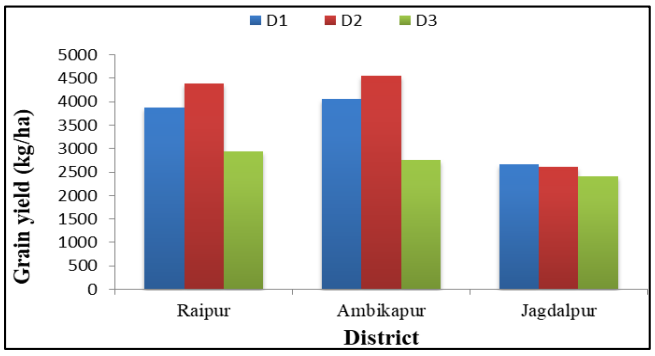


Fig 2: Days of anthesis, maturity and grain yield (kg/ha) of Rajeswari under different dates of sowing (DAS) at different districts of Chhattisgarh

Fig 3: Days of anthesis, maturity and grain yield (kg/ha) of CG Sugandhit Bhog under different dates of sowing (DAS) at different districts of Chhattisgarh

Conclusion

The present study investigates that the temperature rise has differential effects on rice yield in different agro climatic zones are also varied with the different sowing dates. The results shows that for Jagdalpur, the sowing on 1st June it is recommended for getting highest yield from cv. MTU1010, Rajeswari and CG Sugandhit Bhog, However these variety up to 2nd week of June (15 June) for getting good yield in Raipur and Ambikapur agroclimatic zone. Variety MTU1010 can be sown on 1st week of June in Raipur and Ambikapur districts of Chhattisgarh.

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