Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(6): 2404-2406
Received: 28-09-2018
Accepted: 30-10-2018

Avinash Yadu
Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad, Uttar Pradesh, India

Anil Patel
Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad, Uttar Pradesh, India

Shweta Gautam
Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad, Uttar Pradesh, India

Shraddha Rawat
Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad, Uttar Pradesh, India

Correspondence
Avinash Yadu
Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad, Uttar Pradesh, India

Development of multivariate statistical Rice yield prediction model for Raipur district

Avinash Yadu, Anil Patel, Shweta Gautam and Shraddha Rawat

Abstract
The farmers profit is decided by the weather and climatic conditions, climate determines what crops the farmers can grow and weather influences the yield. An attempt has been made in this paper to study the effect of vital weather parameters on Rice yield and to develop a multivariate statistical model for yield forecast of Raipur district Chhattisgarh. On basis of 15 years (2000-2015) weather and rice production 4 types of models have been developed using SPSS software. Result revealed that model 4 was the highest R^2 value 0.97, which describes the 97% variability in rice yield due to weather parameters i.e. maximum temperature of 1^{st} week after sowing, minimum temperature of 13^{th} week after sowing, minimum temperature of 2^{nd} week and maximum temperature of 5^{th} week after sowing. This may be due to more weather factors involved in the Model 4, instead of any other models.

Keywords: Rice, weather parameters, multivariate statistical model, sowing, variability

1. Introduction
The farmers profit is decided by the weather and climatic conditions, climate determines what crops the farmers can grow and weather influences the yield (Watson D. J., 1963) [9]. By establishing the mathematical and statistical techniques between weather and crop a simplified crop weather model can be developed for different regions (Baier W., 1979) [1]. In India rice and wheat are the staple cereals grown in different parts of the country. Rice, being the highest produced cereal in India, is the most important chief food for the major proportion of the population in the country. The consequence of weather parameters at different stages of growth of different crops may help in understanding their response in term of final yield and also provide a forecast of crop yields in advance before the harvest. The temperature, solar radiation and rainfall are some parameters of weather which have direct effect of them on physiological processes of rice and wheat crop. In Chhattisgarh**,** about 82% population depends on agriculture for their livelihood. Favorable soil and climatic conditions helped the state to be a leading producer of paddy, Jawar, groundnut, gram, oilseeds and wheat in the country (NCMRWF, 1990; Venkatraman and Krishnan, 1992; Jain and Ranjana, 2000) [6, 8, 4]. In this paper an attempt was made to estimate the rice yield by including solar radiation as one of the predictors in the regression model.There is requirement to quantify the relationship between crop yield and weather variables in order to predict the regional yield, so that it may be useful for the farmers as well as the policymakers.

2. Materials and methods
2.1 Study area
Chhattisgarh state, situated in eastern India, is located between the latitudes of 17° 46' N -24° 5' N and longitudes of 80° 15' E- 84° 20' E. The climate of Chhattisgarh is tropical. It is hot and humid because of its proximity to the Tropic of Cancer and its dependence on the monsoons for rains. Raipur is situated between 22° 33' N to 21°14'N Latitude and 82° 6' to 81° 38'E Longitude. The average annual temperature in Raipur is 26.8 °C. Precipitation here averages 1276 mm.

2.2 Crops Yield Data
Yearly production (q) and area (ha) under Rice crop in Raipur district for the period 2000-2015 were collected from the (Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare).

2.3 Weather Data
Weekly data of maximum & minimum Temperatures (°C), Relative Humidity (%), Sunshine Hours (hours/day) and Rainfall (mm) number of rainy days for the period 2000-2015 were

collected from the agro meteorological observatory located in I.G.K.V. Raipur Chhattisgarh.

2.4 Development of Statistical Model
The statistical models have been developed for predicting the rice yield in the given environmental conditions. The models were developed based on the weekly weather data of crop season and rice yield. SPSS (Statistical Product and Service Solutions) software was used to develop the statistical model between observed yield and weather parameters. Multiple linear regressions equations have been developed between the dependent variable (yield) and independent variables (weather parameters). The goal of multiple linear regressions (MLR) is to model the relationship between the explanatory and response variables. The model for MLR, given n observations, is:

$$Y_i = B_0 + B_1X_{i1} + B_2X_{i2} + ... + B_pX_{ip} + E$$

Where i = 1, 2,..., n
Y = Dependent Variable, X= Independent Variables, B_1, $B_{2......}$are regression coefficient
In order to find out the relationship between weather variables and rice yield correlation analysis was carried. Correlation studies between yields of crop with the various weather parameters were carried out with the help of methodology described by **G**omez and Gomez (1984) [3].

3. Results
3.1 Relationship between weather variable and rice yield
The result revealed that there was a significant positive and negative relationship between the weather variables and rice yield. The value of correlation coefficients is significant at 1% and 5% level of significance. Positive correlation was found between rice yield and rainfall during whole season. During vegetative phase and maturity stage there was strongly negative correlation with maximum temperature and bright sunshine hours. While strong positive correlation was found with relative humidity. At reproductive and maturity stage in rice there was significantly positive relationship between rice yield and minimum temperature (Table no 2).
Kandiannan *et al.* 2002 [5] also explained the relationship of crop with weather and developed a model for turmeric yield forecasting for Coimbatore district, Tamil Nadu, India.

3.2 Development of multivariate statistical rice yield model
In this study the yield prediction model has been developed for rice crop. The multivariate statistical model for rice has been developed 4 models. Model 1 has shown the R^2 value (0.69) with the variable i.e. maximum temperature of 1st week after sowing. Model 2 has shown the R^2 value (0.81) with the variables i.e. maximum temperature of 1st week & minimum temperature of 13th week after sowing. Model 3 has shown the R^2 value (0.92) with the variables i.e. maximum temperature of 1st week, minimum temperature of 13th week & minimum temperature of 2nd week after sowing and Model 4 has the highest R^2 value 0.97, which describes the 97% variability in rice yield due to weather parameters i.e. maximum temperature of 1st week after sowing, minimum temperature of 13th week after sowing, minimum temperature of 2nd week and maximum temperature of 5th week after sowing. This may be due to more weather factors involved in the Model 4, instead of any other models. (Table no.3).

Fig.1 Depicted that the RMSE values for observed rice yield during the estimation period (2000-2013) of model 1, 2, 3 and 4 were 18.29%, 10.16%, 7.80% and 4.59, respectively and for predicted rice yield during the period (2014-2015) of model 1, 2, 3 and 4 were 70.3%, 61.8%, 65.9% and 52.8%, respectively.
Rajavel *et.al.* 2018 [7] has conducted a study to develop regression model in different districts of Chhattisgarh. The models used to forecast district level yield of rice in Chhattisgarh in mid-season of 2014 and 2015. The forecasted yield obtained has been validated with actual yield of corresponding year to find the accuracy of developed model. The accuracy of forecast model is less than10% in 6 districts in 2014 and 4 districts in 2015.

Table 1: Generalized growth stages of Rice

Phenophases	Growth stages	DAT	SMW
P1	Vegetative stage	1-42	27-32
P2	Reproductive stage	43-70	33-36
P3	Maturity stage	71-98	37-40

Where, P1= Vegetative stage, P2= Reproductive stage, P3= Maturity stage

Table 2: Correlation coefficient between weather parameter and grain yield of Rice at different phenological phases

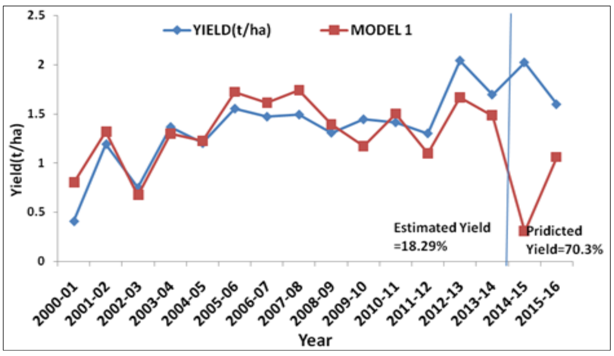
Stage	SMW	Tmax.	Tmini.	RF	RH	BSS
P1	27	-0.832**	-0.554**	0.697**	0.663**	-0.571**
	28	-0.129	0.150	0.189	0.199	0.003
	29	0.244	0.432**	0.336*	0.091	0.161
	30	-0.573**	-0.051	0.179	0.478*	-0.653**
	31	-0.700**	-0.431*	0.591**	0.488*	-0.491**
	32	-0.297*	0.089	0.492*	0.126	-0.155
P2	33	0.396**	0.484**	0.668**	-0.093	0.347**
	34	-0.221	-0.017	0.557**	0.276*	-0.108
	35	0.145	0.399**	0.020	0.084	0.117
	36	0.188	0.574**	0.210	0.162	0.122
P3	37	-0.156	0.681**	0.232	0.412**	-0.201
	38	-0.454*	0.168	0.388*	0.402**	-0.549**
	39	-0.243	0.626**	0.024	-0.012	-0.008
	40	-0.614**	0.581**	0.253*	0.369**	-0.435**

*Significance of r ≥ 0.250 at 5%, **Significance of r ≥ 0.340 at 1%.
Where, P1= Vegetative stage, P2= Reproductive stage, P3= Maturity stage

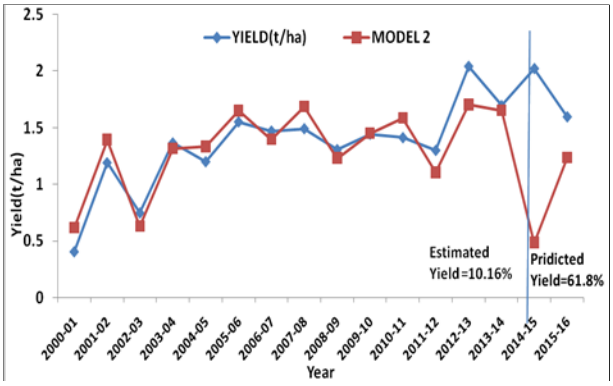
Table 3: Multivariate Statistical models for rice yield

S. No.	Model	R^2
1	Y=7.241-0.184*(X1)	0.69
2	Y=1.440-0.154*(X1)+0.202*(X2)	0.81
3	Y=-5.307-0.145*(X1)+0.278*(X2)+0.187*(X3)	0.92
4	Y=-5.602-0.094*(X1)+0.295*(X2)+0.188*(X3)-0.058*(X4)	0.97

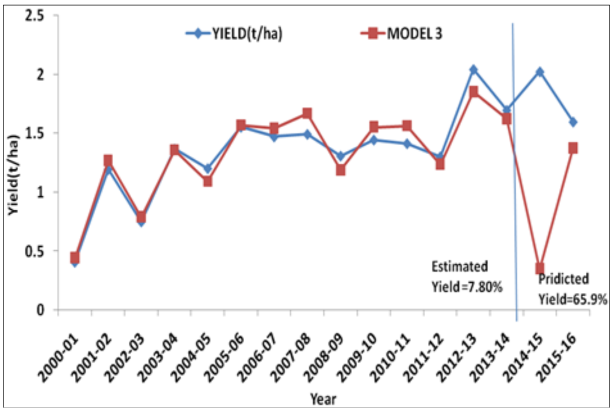
Where, Y=rice yield (t/ha). X1=maximum temperature of 1st week after sowing, X2=minimum temperature of 13th week after sowing, X3=minimum temperature of 2nd week after sowing, X4= maximum temperature of 5th week of sowing.



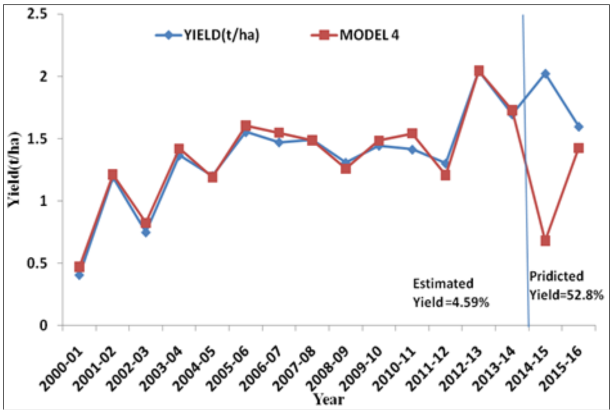
Model 1



Model 2



Model 3



Model 4

4. References

1. Baier W. Note on the terminology of crop weather models. Agric Meteor. 1979; 20:137Ð145.
2. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare.
3. Gomez KA, Gomez AA. Statistical procedures for agricultural research (2 Ed.). John wiley and sons, New York, 1984, 680.
4. Jain RC, Ranjana A. Statistical models for crop yield forecasting. In: S.V. Singh, L.S. Rathore, S.A. Saseendran, K.K. Singh (Eds.), Proceedings of the National Workshop on Dynamic Crop Simulation Modeling for Agro meteorological Advisory. National Centre for Medium Range Weather Forecasting, New Delhi, 2000, 295-304.
5. Kandiannan K, Chandaragiri KK, Sankaran N, Balasubramanian TN, Kailasamd C. Crop–weather model for turmeric yield forecasting for Coimbatore district, Tamil Nadu, India. Agricultural and Forest Meteorology. 2002; 112:133-137.
6. NCMRWF. Crop–weather modeling. Development of Agro meteorology in India, National Center for Medium Range Weather Forecast, New Delhi, 1990, 84-91.
7. Rajavel M, Khare P, Prasad JR, Singh KK, Puranik HV, Das GK. Development of Rice Yield Forecast in Mid-season Using Weather Indices based Agrometeorological Model in Chhattisgarh Vayu Mandal. 2018; 44(1):38-45.
8. Venkatraman S, Krishnan A. Crops and weather. Indian Council of Agricultural Research, New Delhi, 1992, 586.
9. Watson DJ. Climate, weather and plant yield. In: L. T. Evans (ed.), Academic Press, Inc. New York, Environmental Control of Plant Growth, 1963, 337Ð350.