Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(6): 2400-2403
Received: 25-09-2018
Accepted: 27-10-2018

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

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

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

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

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

Weather based forecasting model for chickpea using multivariate-statistical model in Bilaspur district of Chhattisgarh

Anil Patel, Avinash Yadu, Shweta Gautam and Shraddha Rawat

Abstract
The present study investigates the effect of weather variables on the Chick pea crop in Bilaspur district of Chhattisgarh. The analysis has been done for the development of forecasting yield model. Time series data on yield for 16 years (2000-2015) for Bilaspur district has been taken from the website (www.ends.dacnet.nic.in). The weekly meteorological data (2000-2015) has been taken from IGKV, Raipur for Chick pea crop period data. The study has quantified the relationship of weather variables with the yield of Chickpea, with the help of correlation coefficient estimated by Karl Pearson method. Further the yield prediction was done for the crop with help of SPSS model. The multivariate statistical equations were developed for the Chick pea yield prediction from 2000-2013. These equations were then further validated for years 2014 & 2015. On basis of this study it was easy to forecast the yield of Chick pea for Bilaspur district of Chhattisgarh.

Keywords: Weather variables, quantified, correlation, coefficient estimated and multivariate statistical equations

1. Introduction
The changing climatic conditions have a major impact on rainfed crops including pulses (Basu *et al.,* 2009) [1]. Pulses are a wonderful gift of nature as they nourish mankind with highly nutritive food and keep the soil alive and productive Chickpea (*Cicer arietinum* L.) is a cool season crop and third largest globally legume crop, after common bean and field pea. In the World, it occupies an area of 13.54 million hectares with an annual production of 13.31 million metric tons and the average productivity of 971 kg ha (FAO, 2014) [2]. Chhattisgarh is an important state as it contributed about 5.72 per cent of the total annual pulses area chickpea is grown over an area of 393.78 thousand ha with an annual production of 433.158 thousand tonnes and an average productivity of 1100 kg ha^{-1} (Jain *et al*, 1984) [4]. Timely and effective forecasts of the crops are vital for an agrarian economy. Crop yield forecasts are important for advance planning, formulation and implementation of policies related to the crop procurement, distribution, price structure and import export decisions etc. The relationship between crop yield and weather parameters is generally carried out with help of multiple regression models. Considering the importance of legumes this study was carried out to forecast the district level yield forecast of chickpea.

2. Materials and Methods
2.1 Study Area: Bilaspur is located in Chhattisgarh (22° 33' N to 21°14'N Latitude and 82° 6' to 81° 38'E Longitude.) The average temperature in Bilaspur is 26.8 °C. Average precipitation is around 1259 mm (Rice zone) of the state. The weekly maximum and minimum temperature were recorded as 38.1 and 20.5°C respectively.

2.2 Yield Data: Yearly production (q) and area (ha) under chickpea crop in Bilashpur district for the period 2000-2015 were collected from the Statistical Abstract of CHHATTISGARH (Stats, 2013-15). For each year, the total production of the district was divided by the total acreage to calculate the wheat productivity.

2.3 Weather Data: Weekly data of maximum and minimum temperatures, relative humidity, rainfall, sunshine hours and number of rainy days for the period 2000-2015 were collected from the agro meteorological observatory located in the IGKV Raipur Chhattisgarh.

2.4 SPSS Model: SPSS (Statistical Product and Service Solutions) was used to compute Pearson's correlations between observed yield and weather parameters,

and with combinations of weather parameters. Sum of weather parameter and sum product of different weather parameter and correlation coefficient has been derived. Multiple regressions between dependent variable (yield) and independent variables (time, sum and sum products for different weather parameters) were carried out. Regression equation was written using the regression formula

2.5 Statistical Model Development

In this study the thirteen years (2000-2013) data has been used to develop the model and two years (2014 and 2015) data has been used to validate the developed model. Spatio temporal variability in chickpea productivity and climatic variables has been studied in this study using different statistical procedure. The statistical models were developed for yield production of wheat for Bilaspur district using SPSS software. 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 Chickpea 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 Gomez and Gomez (1984) [3].

3 Results

3.1 Relationship between weather variable and Chickpea yield

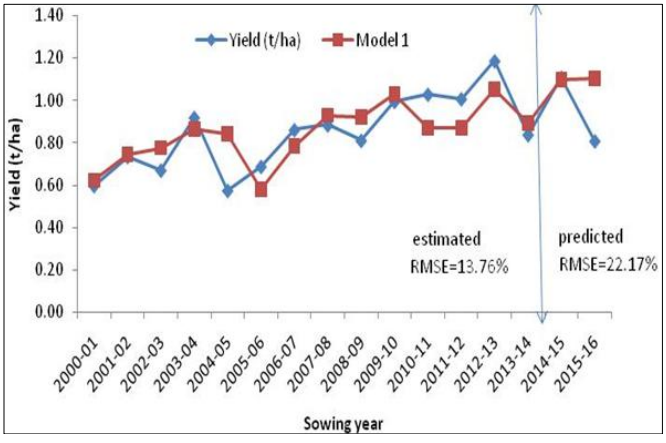
The result revolted that there was a significant and positive and negative relationship between the weather variables and the yield of Chickpea yield of Bilaspur district. (Table 2) shows important weather variables sowing strong and positive/negative relationship between weekly weather variables of crop season and Chickpea yield. The value of correlation coefficients is significant $\alpha = 1\%$ there is positive and strong correlation between minimum temperature and yield during branching stage (49nd SMW to 50thSMW) of Chickpea, while a negative correlation in between them is found during Ripening stage (08th) of crop season. In case of rainfall overall there is negative correlation present between it and Chickpea yield, but in the (50nd and 02nd SMW) of crop season there is strong and positive correlation (r = 0.558 and 0.529 respectively) which leads to 31.1 % and 27.9 % variability in Chickpea yield.

3.2 Development of Multivariate Statistical Chickpea Model

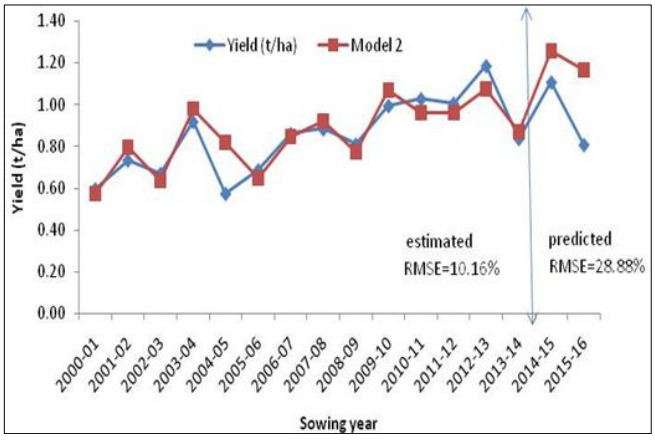
In this study the yield prediction model has been developed for Chickpea crop. The multivariate statistical model for Chickpea has been developed 5 models. Model 1 has shown the R^2 value (0.55) with the variable i.e. minimum temperature of 03st week. Model 2 has shown the R^2 value (0.75) with the variables i.e. minimum temperature of 03st week and Average Maximum temperature of 04th after sowing. Model 3 has shown the R^2 value (0.90) with the variables i.e. maximum temperature of 03rd week, Average Maximum temperature of 04th after sowing and Average rainfall of 08 th week after sowing. Model 4 has shown the R^2 value (0.98) with the variables. maximum temperature of 03rd week, Average Maximum temperature of 04th after sowing and Average rainfall of 08 th week after sowing and average rainfall of 03rd week of sowing. Model 5 has the highest R^2value (0.99) with the variables. maximum temperature of 03rd week, Average Maximum temperature of 04th after sowing and Average rainfall of 08 th week after sowin, average rainfall of 03rd week of sowing and average rainfall of 08 th week of sowing. This may be due to more weather factors involved in the Model 5 has the highest R^2 value 0.997, which describes the 97% variability in Chickpea yield due to weather parameters. This may be due to more weather factors involved in the Model 5, instead of any other models. From Fig. it has been seen that the RMSE of estimated (2.45%) and predicted (93.61%) years are under acceptable limits. (Table no. 3)

(Fig-1) depicted that chickpea highest R^2 value was of Model 5 (0.997), while lowest of Model 1 with one parameter i.e maximum temperature. The RMSE between observed chickpea yield and predicted chickpea yield during the estimated period (2000-2013) was 13.76% for model 1, for model 2 it was10.16%, for model 3 was 6.25%, for model 4 was 4.81% and for model 5 was 2.45% The RMSE of predicted period (2014-2015) between the observed chickpea yield and predicted Chickpea yield by model 1 was 22.17% for model 2 was 28.88% for model 3was 98.97% for model 4 was 97.11% and model 5 was 93.61%.

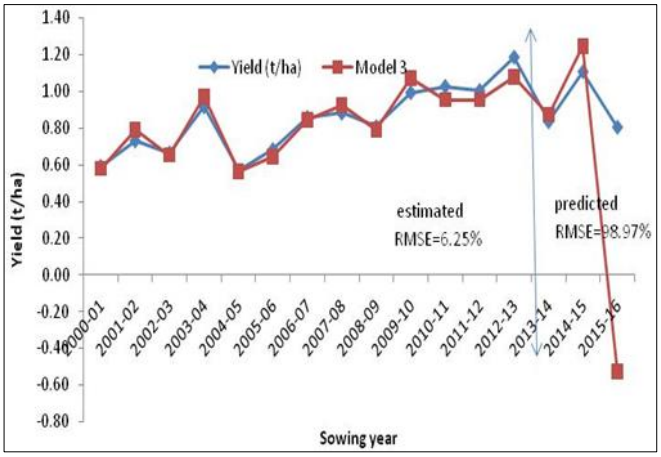
Rajavel *el al.* (2018) [5] has also conducted a study to develop regression model in different districts of Chhattisgarh. The models used to forecast district level yield of rice in Chhattisgarh in mid-season of 2014 and 2015. The forecasted yield obtained has been validated with actual yield of corresponding 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.



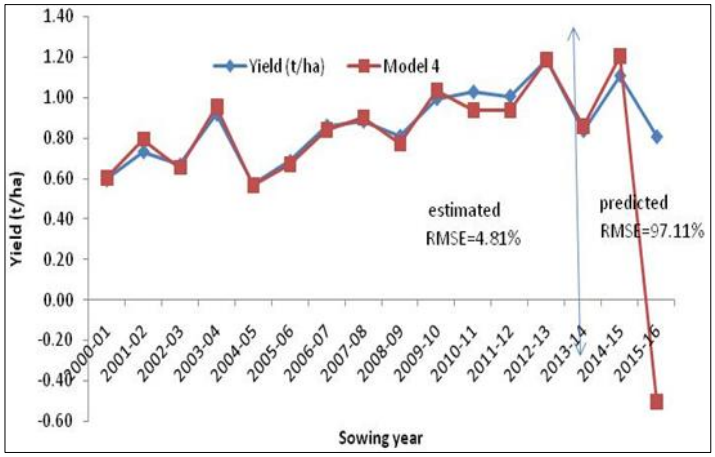
Model (1)



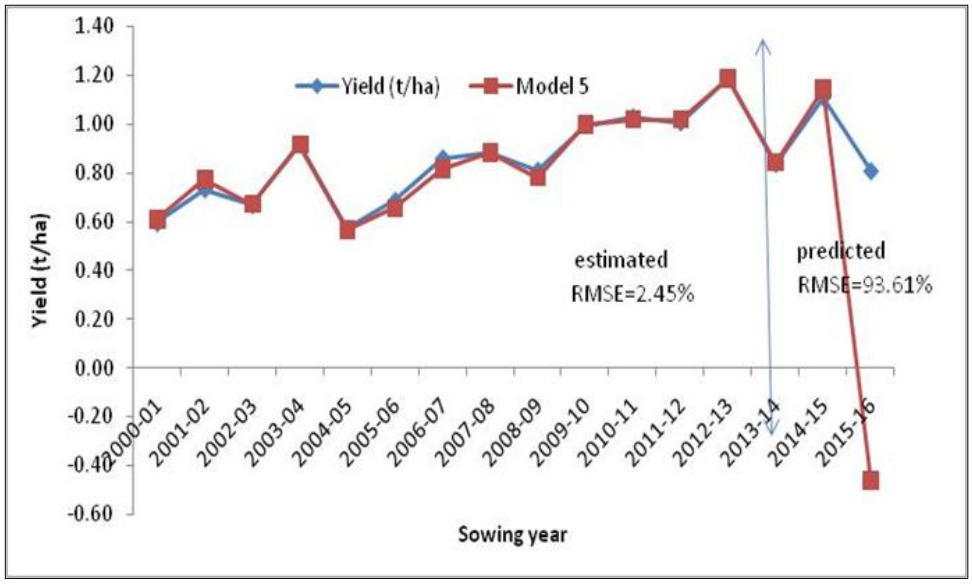
Model (2)



Model (3)



Model (4)



Model (5)

Fig 1: Comparison between observed and predicted Chickpea yield for Bilaspur using Multivariate - meteorological yield model. (1, 2, 3, 4 & 5).

Table 1: Generalized growth stages of chickpea

Pheno phases	Growth stages	DAS	SMW
P1	Branching	1-45	48-52
P2	Flowering	46-75	01-02
P3	Pod filling	76-95	03-05
P4	Ripening	96-110	06-09

Table 2: Correlation coefficient between weather parameter and grain yield of Chick Pea at different phenophases

Growth Stage	SMW	T. max	T. min	Rainfall	RH	BSS
P1	48	0.063	0.224	0.030	0.105	-0.580**
	49	0.474**	0.418**	0.419**	0.014	-0.462**
	50	0.003	0.742**	0.558**	0.495**	-0.661**
	51	-0.491	-0.211	0.247	0.084	-0.384**
	52	0.086	0.137	0.011	0.204	-0.412**
P2	01	0.588**	0.057	0.243	-0.119	-0.377**
	02	-0.174	0.203	0.529**	-0.052	0.007
P3	03	-0.102	0.025	-0.434**	-0.204	-0.077
	04	0.069	0.323*	-0.100	0.145	-0.427**
	05	0.220	-0.016	-0.417**	-0.063	-0.230
P4	06	0.424**	0.225	-0.174	-0.157	-0.336*
	07	-0.198	0.250*	0.049	0.111	-0.094
	08	-0.149	-0.375**	-0.138	0.188	-0.219
	09	0.088	-0.222	-0.002	0.216	0.047

*Significance of $r \geq 0.250$ at 5%, **Significance of $r \geq 0.340$ at 1%

Table 3: Multivariate and R^2 Value developed between Chick pea yield and weather parameters

S. No.	Model	R^2
1.	$Y = -0.172 + 0.073*(X_1)$	.55
2.	$Y = 1.396 + 0.071*(X_1) - 0.056*(X_2)$	.75
3.	$Y = 1.26 + 0.071*(X_1) - 0.051*(X_2) - 0.649*(X_3)$	.90
4.	$Y = 1.36 + 0.061*(X_1) - 0.05*(X_2) - 0.622*(X_3) + 0.078*(X_4)$	.98
5.	$Y = 1.073 + 0.057*(X_1) - 0.038*(X_2) - 0.589*(X_3) + 0.097*(X_4) + 0.043*(X_5)$	.99

Where, Y=Chickpea yield (t/ha). X_1 = average minimum temperature of 03th week after sowing, X_2=Average Maximum temperature of 04th after sowing, X_3=Average rainfall of 08th week after sowing, X_4= Average rainfall of 03th week of sowing, X_5= Average rainfall of 08th week of sowing.

4. References

1. Basu R. High ambient temperature and mortality: a review of epidemiologic studies from 2001 to 2008. Environmental health. 2009; 8(1):40.
2. FAO. Food and Agriculture Organization of the United Nations, Rome, Italy, 2014.
3. Gomez KA, Gomez AA. Statistical procedures for agricultural research (2 Ed.). John Wiley and sons, New York, 1984, 680.
4. Jain RC, Sridharan H, Agarwal R. Principal component technique for forecasting of sorghum yield. Indian J Agric. Sci. 1984; 54(6):467-70.
5. Maity D, Rajavel K, Kumar RTR. Polyvinyl alcohol wrapped multiwall carbon nanotube (MWCNTs) network on fabrics for wearable room temperature ethanol sensor. Sensors and Actuators B: Chemical. 2018; 261:297-306.