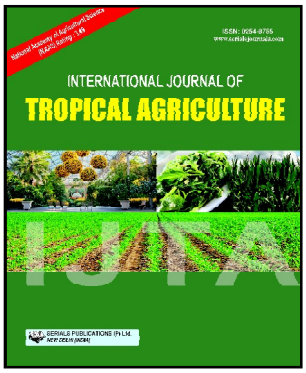

INTERNATIONAL JOURNAL OF TROPICAL AGRICULTURE

ISSN : 0254-8755

available at http: www.serialsjournals.com

Volume 36 • Number 4 • 2018

Pre Harvest Maize Crop Yield Forecast at Different Growth Stage Using Different Model Under Semi Arid Region of India

Ananta Vashisth, Avinash Goyal and Debasish Roy

Division of Agricultural Physics, ICAR-Indian Agricultural Research Institute, New Delhi-110012
E-mail: ananta.iari@gmail.com

Abstract: Timely and accurate forecast provide proper planning in agriculture. Due to increase in input cost of agricultural operation, agriculture produces become costly. Therefore, forecasting in the agriculture become essential. The main factors affecting crop yield are weather, soil and genetic coefficient of the crop. Weather variability causes the losses in the yield. Therefore model based on weather parameters can provide reliable forecast in advance for crop yield. Experiments were conducted at research farm of IARI, New Delhi for pre harvest crop yield forecast of maize. Two varieties of maize were sown at two different dates during *kharif* 2016 seasons. Crop yield forecast were estimated by weather based and crop simulation model. Percentage deviation of estimated yield by actual yield done at flowering stage and at grain filling stage was 10.3 and 7.1 by weather based model, 6.7 and 3.7 by Infocrop model , 15.8 and 12.7 by DSSAT model respectively. Among the three models opted for estimating the yield at flowering and at grain filling stage, Infocrop model gave better results followed by weather based model and DSSAT model.

Keyword: Maize, weather based model, crop simulation model, crop yield forecast

INTRODUCTION

Maize is one of the major crops sown during *Kharif* season in the northern India. It is one of the most important cereal crops in the world agricultural economy. It is grown in almost all the states of India. Crop simulation models are extensively used to establish the relationship between weather parameters and crop growth and yield. They are also used to predict crop yield in advance using the relationship between weather parameters and crop growth. Crop yield forecast is mostly done with crop simulation models and empirical statistical regression

equations relating yield with predictor variables. InfoCrop model has been successfully adapted, calibrated and validated for rice, (Aggarawal et al., 2006b), wheat (Aggarwal et al., 2006a), potato (Singh et al., 2005), cotton (Hebbar et al., 2008) coconut (Kumar et al., 2008). Vashisth, et al (2015) reported that percentage deviation of the observed yield by estimated value of yield forecast done at twenty days before harvest by Infocrop in maize crop was 4.9 and 0.1% for first sown crop, 7.2 and 10.2 % for second sown crop and 11.3 and 5.3% for third sown crop in P-3501 and P-3303 varieties respectively. Percentage deviation of average actual yield from the average pre harvest crop yield forecast was 5.5 and 2.9 % in maize and mustard respectively. Vashisth, et al (2014) reported that the statistical models based upon the weather indices can successfully simulate pre harvest yield forecast of wheat under semi arid region. The percentage deviation between observed and simulated yield was ranged from 5 to 11 and the correlation coefficient was 0.93 to 0.99. Therefore it can be used for district, agro climatic zone and state level forecast. The prime aim of this study is to develop, calibrate and validate crop yield forecast for maize at flowering and at grain filling stage based on the field experiment at IARI research farm using weather based statistical model and crop simulation model.

MATERIALS AND METHODS

Field experiment was conducted at IARI, New Delhi research farm during *Kharif 2016* for predicting pre harvest crop yield forecast of maize. The climate of the station is semiarid with dry hot summers and cold winter. For generating genetic coefficients for maize for running crop simulation models for crop yield forecast at flowering and at grain filling stage, two varieties P3501 and Rasi-333 were sown on two different dates (15th July and 8th August, 2016) with full dose (180 kg/ha) and half dose (90 kg/ha) of nitrogen at experimental farm IARI, New Delhi. The seed rate was 20kg/ha, sowing depth was 4 cm, plant to plant distance was 25 cm and row to row distance was 45 cm. The crops were raised following the standard recommended agronomic practices with three replications. Different growth parameters, LAI, biomass were measured at different dates after sowing. Days and thermal time taken for different phonological stages were measured. Crop yield forecast was estimated at flowering and at grain filling stage by weather based model, Infocrop model and DSSAT model. Percentage deviation of estimated yield by actual yield was calculated after harvest of the crop.

RESULTS AND DISCUSSIONS

The peak LAI occurred at 58 days after sowing in first sown crop and 70 days after sowing in second sown crop. In first and second sowing P-3501 had higher value of LAI than Rasi-333 (Fig 1). Biomass is found to be more in P-3501 than Rasi-333 in first and second sowing. Second sown crop had higher value of biomass followed by First sown crop (Fig. 2). Number of days and Thermal time taken to reach different Phenological stages in maize crop under different weather condition is given in Table 1. The total growing periods for both the varieties were 103 and 95 days in first and second sown crop. The total growing degree days was 1837.9 and 1565.2°C for both the varieties in first and second sown crop.

Estimation of maize crop yield forecast at flowering and at grain filling stage during *kharif* 2016

Maize crop yield forecast at flowering and at grain filling stages was estimated by weather based statistical model for both varieties sown at different dates (table 2). The percentage deviation of crop yield forecast as compared with the actual yield was 10.3 and 7.1 at flowering and at grain filling stage respectively. Using Infocrop model the percentage

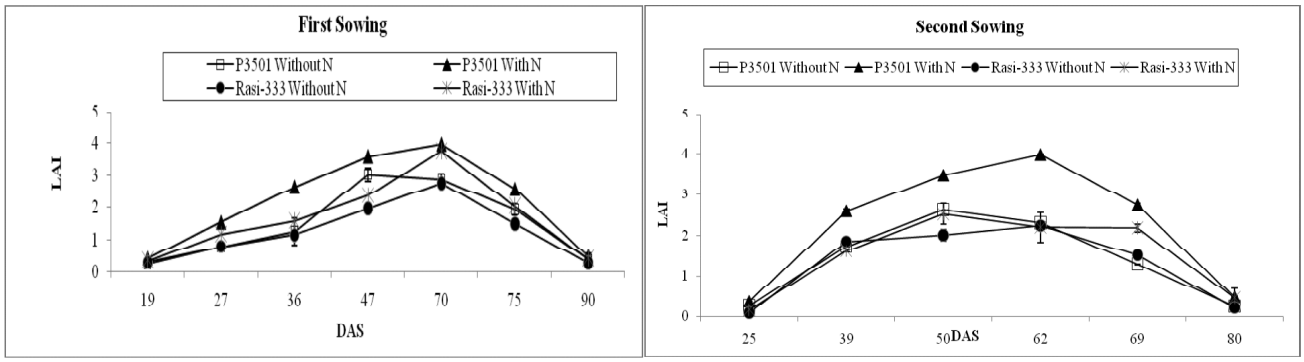

Figure 1: Leaf area index in different varieties of maize under different weather conditions

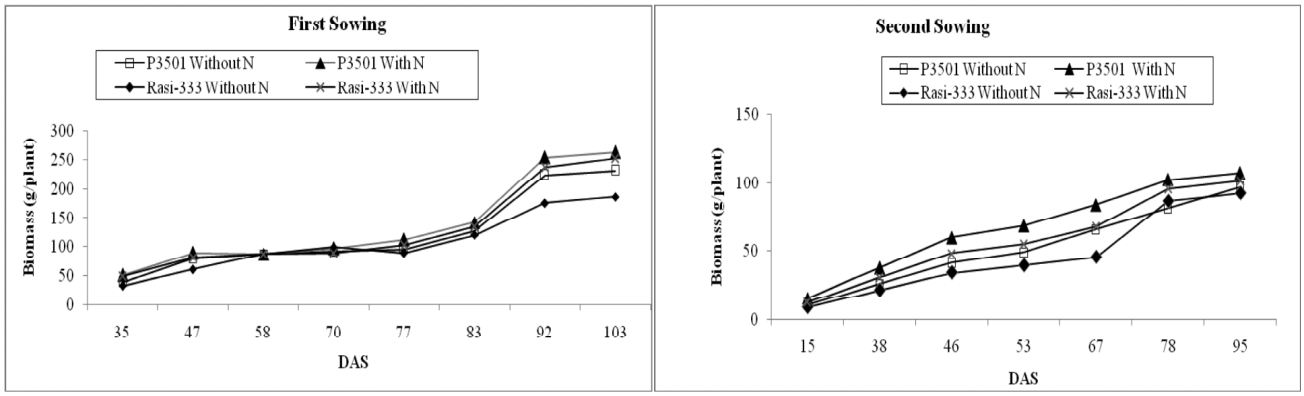

Figure 2: Biomass in different varieties of maize under different weather conditions

Table 1
Number of days and Thermal time taken to reach different Phenological stages in maize crop under different weather conditions

Phenological stage	*First Sowing*		*Second Sowing*	
Variety	P-3501	Rasi-333	P-3501	Rasi-333
		Number of Days		
Emergence	5	6	6	6
50% Flowering	53	54	55	55
Physiological Maturity	96	95	88	88
Harvesting	103	103	95	95
		Thermal Time (°C)		
Emergence	85.1	105.4	112.9	112.9
50% Flowering	894.6	892.3	905.6	905.6
Physiological Maturity	759.6	727.4	478.3	478.3
Harvesting	99.2	112.9	69.5	69.5
Total Thermal Time °C	1837.9	1837.9	1565.2	1565.2

deviation of estimated yield by actual yield was 3.7 and 6.7 respectively at flowering and at grain filling stage (table 3). However using DSSAT model the percentage deviation of estimated yield by observed yield was 12.7 and 15.8 respectively at flowering and grain filling stage (table 4).

Table 2
Maize crop yield forecast at flowering and at grain filling stages during *kharif*, 2016 using weather based model

Date of Sowing	*Regression Equation*	*Weather Element*	*Estimated Yield (kg/ ha)*	*Actual Yield (kg/ ha)*	*% Deviation*
	Yield forecast of Maize Crop at flowering stage				
First Sowing (15-07-16)	Y=393.6+0.098*Z341 +117.9*Time	RF & RHI	3542.2	3179.6	11.4
Second Sowing (3-12-16)	Y=(-4482.2) + 5.12* Z121 + 130.77*Time	Tmax & Tmin	3443.09	3155.7	9.1
	Average		3492.6	3167.5	10.3
	Yield forecast of Maize Crop at grain filling stage				
First Sowing (15-07-16)	Y=419.9+0.09*Z341 +115.3* Time	RF & RHI	3469.8	3179.6	9.1
Second Sowing (08-08-16)	Y=551.6+0.14*Z351 +112.1*Time	RF & RHII	3314.3	3155.7	5.0
Average			3392.05	3167.35	7.1

Table 3
Maize crop yield forecast at flowering and at grain filling stages during *kharif*, 2016 using Infocrop Model

Variety	*Estimated yield*	*Actual Yield*	*% Deviation*
	Yield forecast of Maize Crop at flowering stage		
First Sowing (15-07-16)	3343	3179.6	5.1
Second Sowing (08-08-16)	3414.1	3155.7	8.2
Average	3378.5	3167.7	6.7
	Yield forecast of Maize Crop at grain filling stage		
First Sowing (15-07-16)	3252	3179.6	2.3
Second Sowing (08-08-16)	3319	3155.7	5.2
Average	3285.5	3167.7	3.7

Table 4
Maize crop yield forecast at flowering and at grain filling stages during *kharif*, 2016 using DSSAT Model

Variety	*Estimated yield*	*Actual Yield*	*% Deviation*
Yield forecast of Maize Crop at flowering stage			
First Sowing (15-07-16)	3698	3179.6	-16.3
Second Sowing (08-08-16)	3640	3155.7	-15.3
Average	3669	3167.65	-15.8
Yield forecast of Maize Crop at grain filling stage			
First Sowing (15-07-16)	3648	3179.6	-14.7
Second Sowing (08-08-16)	3490	3155.7	-10.6
Average	3569	3167.7	-12.7

CONCLUSION

The percentage deviation of the estimated yield by actual yield done at flowering stage was 11.4 and 9.1 by weather based model, 5.1 and 8.2 by Infocrop model, 16.3 and 15.3 by DSSAT model respectively for first and second sown crop. At grain filling stage the percentage deviation of the estimated yield by actual yield for first and second sown crop was 9.1 and 5.0 by weather based model, 2.3 and 5.2 by Infocrop model, 14.7 and 10.6 by DSSAT model respectively. Percentage deviation of average estimated yield from the average actual yield at flowering and at grain filling stage was 10.3 and 7.1 by weather based model, 6.7 and 3.7 by Infocrop model, 15.8 and 12.7 by DSSAT model respectively. From the studies it was concluded that among the three models opted for estimating the yield at flowering and at grain filling stage, Infocrop model gave better results followed by weather based model and DSSAT model.

ACKNOWLEDGEMENT

Authors are thankful to Director IARI, New Delhi for providing the facilities and also India Meteorological Department for funding the research project.

REFERENCES

Aggarwal, P.K., Banerjee, B., Daryaei, M.G., Bhatia, A., Bala, A., Rani, S., Chander, S., Pathak, H. and Kalra, N. (2006a). Infocrop: a dynamic simulation model for the assessment of crop yields, losses due to pests, and environmental impact of agro-ecosystems in tropical environments. I. Model description. *Agric. Syst.* 89: 1-25.

Aggarwal, P.K., Kalra, N., Chader, S. and Pathak, H. (2006b). Infocrop: a dynamic simulative model for the assessment of crop yields, losses due to pests, and environmental impact of agro-ecosystems in tropical environments. I. Performance of the model. *Agric. Syst.* 89: 47-67.

Hebbar, K.B.,Venugopalan, M.V., Seshasai, M.V.R., Rao, K.V. , Patil, B.C., Prakash, A.H., Kumar,V., Hebbar, K.R., Jeyakumar, P., Badopadhyay, K.K., Rao, M.R.K., Khadi, B.M. and Aggarwal, P.K. (2008). Predicting cotton production using Infocrop-cotton simulation model, remote sensing and spatial agro-climatic data. *Curr. Sci.* 95: 570-579.

Kumar, S.N., Bai, K.V., Rajgopal, V. and Aggarwal, P.K. (2008). Simulating coconut growth, development and yield with the Infocrop-cocnut model. *Tree Physiol.* 28: 1049-1058.

Singh, J. P., Govindakrishnan, P.M., Lal, S.S. and Aggarwal, P.K. (2005). Increasing the efficiency of agronomic

experiments in potato using Infocrop-potato model.*Potato Res.* 48:131-152.

Vashisth, Ananta, Singh R. and Manu Choudary (2014). Crop yield forecast at different growth stage of wheat crop using statistical model under semi arid region Journal of Agroecoogy and Natural Resource Management : 1-3

Vashisth, Ananta, Choudary, Manu, Joshi, D. K. and Baloda, R. (2015). Pre harvest yield forecast in maize-mustard cropping system under semi arid region using crop simulation model. *International Journal of Tropical Research*. 33 (2):1059-1067.