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Preharvest forecasting of castor yield on the basis of biometrical variables

G. K. CHAUDHARY[1], J. K. PATEL[2], B. H. PRAJAPATI[3], M. G. CHAUDHARY[4] AND R. I. PRAJAPATI[5]

Dept. of Agril. Statistics, C. P. College of Agriculture
S. D. Agricultural University Sardarkrushinagar- 385 506 (Gujarat)

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ABSTRACT

To suggest most suitable pre-harvest forecasting model for Banaskantha district of Gujarat state, two talukas (*i.e.*, Palanpur and Vadgam) of Banaskantha district were selected randomly. Five villages were also randomly selected from each of the two selected talukas. The fields of ten castor grower farmers were randomly selected from each of the selected villages. Biometrical variables were recorded from each of the randomly selected 100 samples (fields of farmers) during the years 2007-08 and 2008-09 by specially trained 10 workers, who had recorded the data from 100 farmer's field. The step-wise regression procedure was employed by using total 21 biometrical variables and two dummy variables. It was revealed that for all the three models (120, 150 and 180 DAS) fitted in this approach, the periods (150 and 180 DAS) were found suitable for predicting castor yield in Banaskantha district. The model for 150 DAS was found more suitable because earliest forecasting is always better. Thus, précised castor yield forecast by applying 150 DAS model is possible two months before actual harvest by using biometrical variables.

Key words : Forecast, biometrical variables, castor yield, step-wise regression.

Castor [*Ricinus communis* (L.)] is an important non-edible oil seed crop of arid and semi-arid regions of India. The crop has wide adaptability and grown in tropical, sub-tropical and temperate regions of the world. India is the largest castor producer in the world with 7.40 lakh hectares area and 1262 kg/ha productivity during 2009-10. Banaskantha district ranks first in area *i.e.,* 97.93 thousand hectares and productivity *i.e.*, 1820 kg/ha. (Anonymous 2010) in the Gujarat State. The input variables as well as the environmental factors contribute significantly towards the growth of plant variables. Therefore, selection of a set of biometrical variables are likely to play a significant role in selecting better pre-harvest forecasting models. It is also essential to identify the major plant biometrical variables which can be recorded well in advance before harvest and can be used in forecasting crop yield.

The literature on yield forecasting of different crops is available in plenty. But, such information is very scanty for castor crop, being largely grown in Gujarat, where castor seed and castor oil are economically important products. Therefore, present investigation was carried out to suggest suitable pre-harvest forecast model of castor yield in Banaskantha district based on biometrical variables. Sizeable literature is available wherein authors have used either biometrical variables (Jha *et al.,* 1981 in sugarcane) or weather variables (Khistaria *et al.*, 2004 and Malik *et al.,* 2000) in pre-harvest yield forecasting of various crops. But, Kokate *et al.* (2000) used jointly both biometrical and weather variables for rice yield forecasting at Dapoli, Maharashtra.

MATERIALS AND METHODS

In present study an attempt has been made to formulate a relationship for predicting the castor yield (Y) by investigating the influences of important

[1&5]Assistant Professor, [2]Professor, [3]Professor & Head, [4]Assistant Professor, Dept. of Agronomy.

biometrical variables viz., plant height, number of effective branches, days to 50 % flowering, length of main spike, days to maturity, number of effective spikes per plant, number of effective capsules per plant, seed yield per plant, 100 seed weight and oil content along with two dummy variables, sowing date and variety on the yield of castor crop. To estimate the effect of biometrical variables, two talukas (*i.e.*, Palanpur and Vadgam) of Banaskantha district were selected randomly. Five villages were also randomly selected from each of the two selected talukas. The fields of ten castor grower farmers were randomly selected from each of the selected villages. Thus, biometrical variables (Table 1) were recorded from each of the randomly selected 100 samples (fields of farmers) during the years 2007-08 and 2008-09 by specially trained 10 workers, who had recorded the data from 100 farmers' field.

The mathematical model (Agrawal *et al.*, 1980) for the approach was

Table 1 Description of biometrical variables included in the model

Variables	Description
X_1	Plant height (cm.) at 60 DAS
X_2	Plant height (cm) at 80 DAS
X_3	Plant height (cm) at 100 DAS
X_4	Plant height (cm) at 120 DAS
X_5	No. of effective branches per plant at 120 DAS
X_6	No. of effective branches (cum.) per plant at 150 DAS
X_7	No. of effective branches (cum.) per plant at 180 DAS
X_8	Days to 50 % flowering
X_9	Length of Main spike (cm.)
X_{10}	Days to maturity
X_{11}	No. of spikes per plant at 120 DAS
X_{12}	No. of spikes (cum.) per plant at 150 DAS
X_{13}	No. of spikes (cum.) per plant at 180 DAS
X_{14}	No. of capsules per plant at 120 DAS
X_{15}	No. of capsules (cum.) per plant at 150 DAS
X_{16}	No. of capsules (cum.) per plant at 180 DAS
X_{17}	Seed yield per plant at 120 DAS (g)
X_{18}	Seed yield (cum.) per plant at 150 DAS (g)
X_{19}	Seed yield (cum.) per plant at 180 DAS (g)
X_{20}	100 seed weight. (g)
X_{21}	Oil content (%)
X_{22}	Sowing date as dummy variable
X_{23}	Variety as dummy variable

* cum.:cumulative

$$Y = A_0 + \sum_{i=1}^{p} \sum_{j=1}^{s} a_{ij} X_{ij}$$

Where,

Y = Average castor yield (g/plant)

A_0 = Constant

X_{ij} = Observed value of i^{th} biometrical variable in j^{th} farmer's field i = 1, 2,..,p = 23 and j = 1,2..,s = 100

a_{ij} is partial regression coefficient associated with each X_{ij}.

Using this approach the forecast models were fitted using step-wise regression technique (Draper and Smith, 1966) with probability level of 0.059 to enter and 0.62 to remove the variables and simulated forecast errors were worked out for the year 2008-09 which were not included in fitting the model.

RESULTS AND DISCUSSION

The partial regression coefficients, coefficients of multiple determinations and standard errors for three different models corresponding to 120, 150 and 180 DAS are depicted in Table 2. The corresponding simulated forecasts for the subsequent year 2008-09 (which was not considered for fitting the model) and their per cent deviation from actual average yield on farmer's field are presented in Table 3.

In fitted model for 120 DAS (Table 2), the set of biometrical variables entered in the equation were X_8, X_{14}, X_{17} and X_{20}. These variables explained 65.30 % variation in yield of castor crop. In case of 150 DAS, the variables entered were X_5, X_6, X_{15}, X_{17} and X_{18} and they explained 96.00 % variation in castor yield. However, for 180 DAS, they were X_1, X_2, X_5, X_7, X_{16} and X_{19}, which explained 98.10 % variation in the yield of castor crop. The results revealed that the partial regression coefficients for the variables namely plant height (cm) at 60 DAS (X_1), no. of effective branches (cumulative) per plant at 150 DAS (X_6), no. of effective branches (cumulative) per plant at 180 DAS (X_7), days to 50 % flowering (X_8), no. of capsules (cumulative) per plant at 120 DAS (X_{14}), no. of capsules (cumulative) per plant at 150 DAS (X_{15}), no. of capsules (cumulative) per plant at 180 DAS

(X_{16}), seed yield (cumulative) per plant at 150 DAS (X_{18}) and seed yield (cumulative) per plant at 180 DAS (X_{19}) were found positive and significant. Seed yield per plant at 120 DAS (X_{17}) found positive and significant in the model of 120 DAS but, it was negative and significant in model of 150 DAS. However, the partial regression coefficients corresponding to the variables plant height (cm) at 80 DAS (X_2) and no. of effective branches (cum.) per plant at 120 DAS (X_5) were found negative and significant in model 180 DAS.

Table 2 Partial regression coefficients of castor yield on different biometrical variables in biometrical variable approach.

Variables in the equation	Year 2007-08		
	120 DAS	150 DAS	180 DAS
Constant	-118.46 (43.59)	-9.36 (9.50)	-9.56 (7.38)
X_1 Plant height (cm.) at 60 DAS	-	-	0.32** (0.08)
X_2 Plant height (cm.) at 80 DAS	-	-	-0.23** (0.071)
X_5 No. of effective branches per plant at 120 DAS	-	-12.06** (2.65)	-7.23** (1.67)
X_6 No. of effective branches (cum.) per plant at 150 DAS	-	4.00** (1.48)	-
X_7 No. of effective branches (cum.) per plant at 180 DAS	-	-	2.99** (0.73)
X_8 Days to 50 % flowering	4.41** (0.80)	-	-
X_{14} No. of capsules per plant at 120 DAS	0.45* (0.21)	-	-
X_{15} No. of capsules (cum.) per plant at 150 DAS	-	0.17** (0.06)	-
X_{16} No. of capsules (cum.) per plant at 180 DAS	-	-	0.13** (0.04)
X_{17} Seed yield per plant at 120 DAS	3.32** (0.35)	-1.00** (0.18)	-
X_{18} Seed yield (cum.) per plant at 150 DAS	-	2.37** (0.09)	-
X_{19} Seed yield (cum.) per plant at 180 DAS	-	-	1.18** (0.03)
X_{20} 100 seed weight. in g	-1.54* (0.70)	-	-
S.E.	27.52	9.37	6.52
R^2 (%)	65.30**	96.00**	98.10**

Figures in parenthesis indicate standard error

* Significant at 5 % level of significance** Significant at 1 % level of significance

Table 3 Simulated forecasts based on the fitted equations (2008-09) for 100 farmer's field

	Observed yield (g/plant)	Simulated forecasts (g/plant) for the year 2008-09		
		120 DAS	150 DAS	180 DAS
Mean	350.0	373.5 (-7.17)	366.3 (-4.87)	364.7 (-4.38)
Range	279.6 to 466.2	287.3 to 476.6 (-24.97 to 6.69)	298.7 to 470.7 (-24.46 to 2.50)	293.9 to 477.7 (-19.96 to 0.40)

Figures in parenthesis are per cent deviations from observed yield.

The simulated forecasts of castor yield at 120 DAS, 150 DAS and 180 DAS (Table 3) showed deviations from -24.97 to 6.69 per cent, -24.46 to 2.50 per cent and -19.96 to 0.40 per cent from observed yield, respectively.

Comparison of the models, with respect to their predictability and the deviations of predicted values from the actual yield, revealed that for all the three models (120, 150 and 180 DAS) fitted in this approach, coefficient of determination (R^2) was higher (≥ 96 %) in case of 150 and 180 DAS model than the 120 DAS (65.30 %). The deviations of simulated forecasts from observed yield (Fig.1) were much lower in case of 180 DAS and 150 DAS than the 120 DAS. Similar trend was noticed in case of standard error (S.E.) also. Hence both the periods (150 and 180 DAS) was found suitable for predicting castor yield in Banaskantha district. In case of forecasting, earliest forecasting is always better. Hence, the model 150 DAS was found more suitable (R^2 = 96.00 %) than 180 DAS. Thus, pre-harvest forecast model based on biometrical variables for Banaskantha district of North Gujarat is suggested as below:

$$Y = -9.36 - 12.06^{**}X_{11} + 4.00^{**}X_{12} + 0.17^{**}X_{21} - 1.00^{**}X_{23} + 2.37^{**}X_{24} \left(R^2 = 96.00\%\right)$$

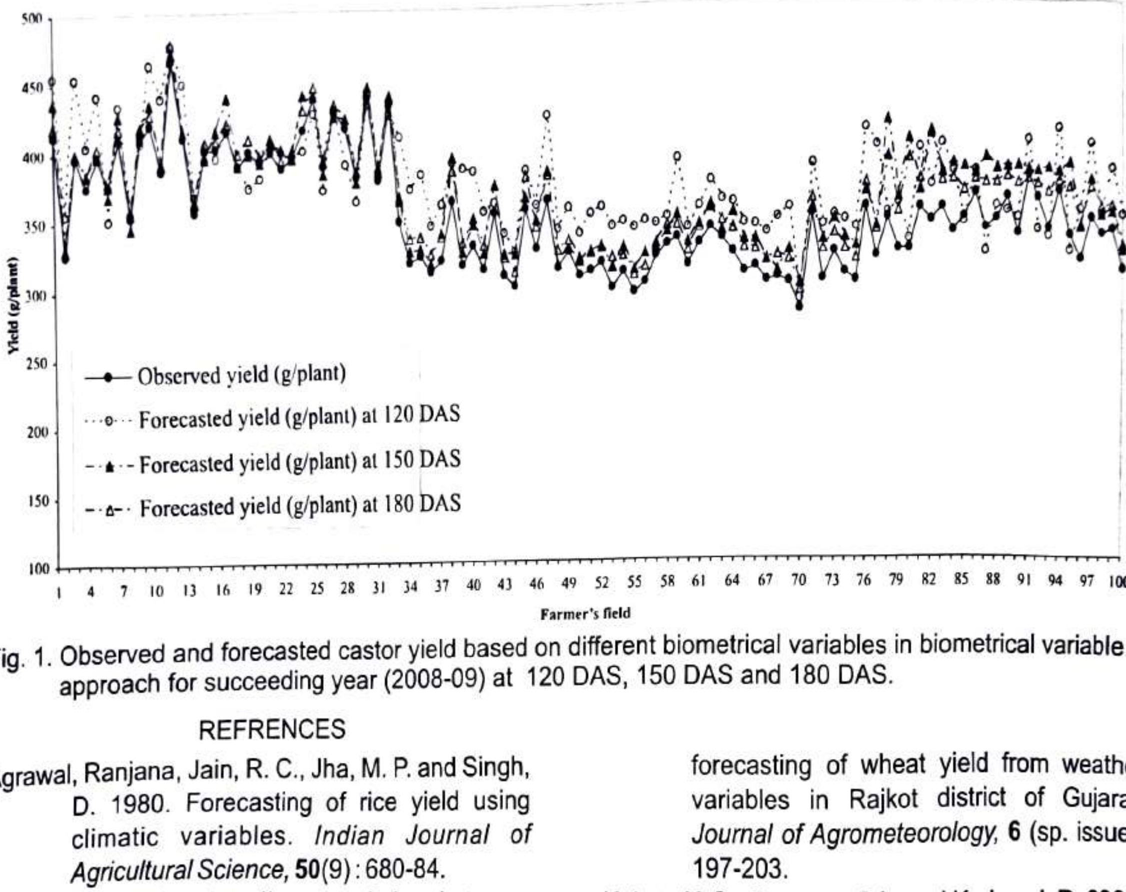

Fig. 1. Observed and forecasted castor yield based on different biometrical variables in biometrical variable approach for succeeding year (2008-09) at 120 DAS, 150 DAS and 180 DAS.

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