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Relationship between rainfall and groundnut productivity of Junagadh district in Gujarat state

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ABSTRACT

The district-wise average yield data of groundnut and daily rainfall data were used over a period of 33 years i.e. from 1970-2002. Five broad criteria were tried to investigate the relationship between rainfall and groundnut productivity. They were (1) Seasonal rainfall (2) Monthly rainfall (3) Fortnightly rainfall (4) Week-wise rainfall and (5) Crop phase-wise rainfall. Comparison of different regression equations with respect to the coefficient of determination (R^2) revealed that the equations, which considered weekly rainfall variables as a set of predictor variables exhibited the highest R^2 values. The regression equation, using crop phase-wise and week-wise rainfall criteria suggested that flowering and peg initiation and full pegging to pod development stages were the most critical phases with respect to moisture requirement of groundnut.

India is one of the major oilseeds producing countries in the world. Among the five major oil seed crops *viz.* groundnut, castor, mustard, linseed and sesame grown in the country, groundnut (*Arachis hypogaea* L.) occupies the first rank in terms of area and production. Gujarat occupies about 30 per cent of the total area of groundnut in the country and contributes about 38 per cent of the production (Anon. 2002). Groundnut crop is predominantly grown as rainfed crop in *kharif* season in Saurashtra region of Gujarat. The region comprises six districts *viz.* Junagadh, Amreli, Rajkot, Bhavnagar, Jamnagar and Surendranagar. The year to year fluctuation in the crop yields is attributable mainly to the variation in rainfall and its distribution.

Khatri and Patel (1982) studied the effect of rainfall distribution along with the eye-estimates for five major groundnut growing districts of Saurashtra region using 21 years data (1957-77). The effect of rainfall pattern on the productivity of groundnut was studied by several scientists (Suryanarayana *et al.*, 1982, Sahu *et al.*, 2004). Patel and Vaishnav (1990) studied the effect of rainfall on groundnut yield under dry framing situation of Gujarat. Khatri and Patel (1990) tried to locate critical phases in groundnut crop by selecting rainfall variables through stepwise regression analysis technique. The effect of rainfall distribution on the yield of groundnut during its growth period was studied by Singh and Singh (1994) in Rajkot

district of Gujarat. Forecasting of groundnut yield using rainfall variables for Saurashtra region of Gujarat was reported by Parmar *et. al.* (2004). The present investigation has been taken up to study the effect of rainfall and its distribution on the yield of groundnut and also to have pre-harvest estimate of groundnut yield in Junagadh district of Gujarat state.

MATERIALS AND METHODS

The soil type in Junagadh district is medium black and the normal annual rainfall 08 mm. The district average yield data a period of 33 years. *i.e.* from 1970-2002 and the corresponding daily rainfall data were collected from the Directorate of Agriculture, Gujarat state, Gandhinagar (Anon. 2003). Five criteria of periods were tried to investigate the relationships between rainfall and groundnut productivity. They were (1) Seasonal rainfall (2) Monthly rainfall (3) Fortnightly rainfall (4) Week-wise rainfall and (5) Crop phase-wise rainfall. In case of seasonal rainfall criteria, total of 17 weeks rainfall (23rd to 39th Meteorological Standard Weeks) was considered as predictor variable. For monthly rainfall criteria, the rainfall values of the four individual months (June, July, August and September) were taken as set of independent variables. In case of fortnight rainfall criteria, the fortnightly total rainfall for the month of June, July, August and September were considered as predictor variables. In the week-wise rainfall criteria, the weekly rainfall recorded in 17 weeks (23rd to 39th MSW) were taken as sets of independent variables (X_1 to X_{17}). For crop phase-wise criteria, the 17 weeks rainfall was divided into subgroups according to the five crop phases (*i.e.* Pre-sowing (23rd and 24th MSW), Germination and vegetative growth (25th to 27th MSW), Flowering and peg initiation (28th to 31st MSW), Full pegging to pod development (32nd to 36th MSW) and Pod maturation (37th to 39th MSW)) and the corresponding rainfall values were taken as a set of predictor variables. Total growth period has been considered as 120 days. The daily rainfall during the crop season *i.e.* from 3rd June to 30th September (23rd to 39th MSW) recorded at the Junagadh weather station was used in the study. For Fortnightly and Week-wise rainfall criteria, the step-wise regression technique was employed for fitting statistical models.

RESULTS AND DISCUSSION

Seasonal rainfall criteria

The result revealed that regression coefficient of groundnut productivity on seasonal rainfall was found highly significant and positive(0.943), this indicated that the seasonal rainfall received during the season has positive influence on productivity of groundnut. However, the predictability of productivity as judged by the R^2 values was very low. The fitted model was as under

$$Y = 491.371 + 0.943^{**} X, \qquad (R^2 = 0.32)$$

Where X=Seasonal Rainfall received during 23rd to 39th MSW

Monthly rainfall criteria

The result indicated that splitting of total rainfall of the season into four monthly

variables improved R^2 value as compared to that obtained by aggregate rainfall approach. However, the predictability was increased by only about 14 per cent, which is not sufficient for prediction. The fitted model was as under

$$Y = 476.902 + 1.261^{*} M_{Jun} + 0.673 M_{Jul} - 0.089 M_{Aug} + 2.617^{**} M_{Sep}, \quad (R^2 = 0.46)$$

Fortnightly rainfall criteria

The fitted model was as under

$$Y = 354.396 + 2.134^{*} F_1 + 1.048 F_2 + 0.711 F_3 + 1.342^{*} F_4 + 2.094^{*} F_6 + 3.082^{**} F_7 \quad (R^2 = 0.64)$$

Where F_1=1st fortnight of June, F_2=2nd fortnight of June, F_3=1st fortnight of July, F_4=2nd fortnight of July, F_6=2nd fortnight of August, F_7=1st fortnight of September

The result revealed that, the rainfall received during 1st fortnight of June, 2nd fortnight of July and August and 1st fortnight of September contributed significantly to the groundnut yield. All these variables accounted about 64 per cent of variation in groundnut yield. It was also observed that splitting of aggregate rainfall into fortnight rainfall, the predictability of the model increased by about double as compared to seasonal rainfall criteria, and increased by 18 % over monthly criteria. .

Weekly rainfall criteria

In this criteria rainfall data were further splitted into shorter interval of a week. The pre-harvest prediction periods tried are presented in Table 1.

The results presented in Table 2 reveal that in case of 17 and 15 weeks models, the partial regression coefficients corresponding X_2, X_5, X_7, X_{13} and X_{14} were positive and significant. In 13 weeks model, X_3, X_8 and X_{13} recorded positive and significant partial regression coefficients, while in 11 weeks model, X_1, X_3 and X_6 exerted positive and significant partial regression coefficients. The value of R^2 ranged from 0.42 to 0.68. Thus, the results suggest that earliest prediction of groundnut yield is possible four weeks before harvest (at the end of 37th MSW) with an accuracy level of 68.0%.

Crop phase-wise rainfall approach

The fitted model was as under

$$Y = 456.857 + 2.392^{*} S_1 + 0.508 S_2 + 0.966^{*} S_3 + 1.870^{**} S_4 - 0.577 S_5 \quad (R^2 = 0.49)$$

Where S_1 = Pre-sowing, S_2 = Germination and vegetative growth, S_3 = Flowering and peg initiation, S_4= Full pegging to pod development, S_5 = Pod maturation

It is inferred that rainfall during S_1, S_3 and S_4 crop phases had significant positive effect and therefore indentified as most critical periods of rainfall for good groundnut yield in Junagadh district.

The examination of the above prediction equations indicated favourable impact of the rainfall variable coinciding to pre-sowing (X_2), germination and vegetative

Table 1 : Pre-harvest prediction period for four different statistical models

No. of weekly rainfall variables considered		Variable codes	Prediction period
MSW	No. of weeks		
23-39	17	X_1 to X_{17}	39th standard weeks
23-37	15	X_1 to X_{15}	37th standard weeks
23-35	13	X_1 to X_{13}	35th standard weeks
23-33	11	X_1 to X_{11}	33rd standard weeks

Table 2 : Yield prediction models for groundnut using weekly rainfall

Variables	Up to 17 weeks	Up to 15 weeks	Up to 13 weeks	Up to 11 weeks
Constant	375.892	375.892	467.261	489.427
Reg. Coeff.				
X_1	–	–	–	6.055* (2.345)
X_2	3.112** (0.941)	3.112** (0.941)	2.055 (1.083)	1.887 (1.286)
X_3	1.737 (1.011)	1.737 (1.011)	2.639* (1.078)	3.326* (1.328)
X_4	–	–	–	0.950 (0.784)
X_5	1.818* (0.699)	1.818* (0.699)	1.122 (0.728)	–
X_6	–	–	–	1.981* (0.851)
X_7	1.786* (0.774)	1.786* (0.774)	–	–
X_8	–	–	3.896* (1.569)	–
X_{10}	1.241 (0.895)	1.241 (0.895)	–	–
X_{11}	2.303 (1.267)	2.303 (1.267)	2.604 (1.390)	2.627 (1.662)
X_{13}	2.953** (1.086)	2.953** (1.086)	4.670** (1.148)	–
X_{14}	4.716** (1.393)	4.716** (1.393)	–	–
R^2	0.68	0.68	0.57	0.42

** Significant at 5 % level, ** Significant at 1 % level, Figures in parentheses are standard errors*

growth (X_5), flowering and peg initiation (X_7) and full pegging to pod development (X_{13} and X_{14}).

Among all the models fitted, the model using weekly rainfall (up to 15 th week i.e.37 MSW) variables as a set of predictor variables had the highest predictability (R^2 = 0.68). It also indicated that rainfall received during shorter interval (week as criteria) had higher influence as compared to seasonal, monthly, fortnightly and stage wise criteria. Similar finding have been reported by Khatri and Patel (1982 & 1990), Patel and Vaishnav (1990) and Parmar *et.al.*(2004) in Saurashtra region of Gujarat state for groundnut crop.

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