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Stepwise regression technique to predict pigeonpea yield in Varanasi District

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ABSTRACT

A stepwise regression technique had been utilized to study the sensitive periods corresponding to the highest correlation coefficient for climatic variables with pigeonpea yield at Varanasi to develop prediction equation. The pigeonpea yield variation explained by weather variables is 94% which is significant at 0.1 level. The estimated and predicted yields at Varanasi are within 6.5% and 7% respectively of the actual yields. This technique is also capable in predicting the yield of low production year with fairly good accuracy.

Key words : Pigeonpea, Yield prediction, Stepwise regression

The problem of predicting crop yield has occupied the attention of agronomists, soil scientists, plant physiologists as well as meteorologists for many years. The methods of predicting yield ranges from statistical approaches (Stewart and Dwyer, 1990; Shanker and Gupta, 1987 and 1988, Gupta and Singh 1988,1990) to crop simulation models (Aggrawal and Kaira, 1994; Hundal and Kaur, 1997; Singh *et al*., 1999). The former depends heavily on empirical correlations between yield and climatic variables, while the latter simulate the crop biophysical processes that underline crop growth and development to produce grain yield. Parthasarathy *et al*. (1988) have developed prediction equation based on regression model, for total Indian food grain production using monsoon rainfall. The forecast equations have also been developed for predicting paddy yield (Shanker and Gupta, 1987 and1988), for estimation of sugarcane yield (Gupta and Singh, 1988) and for cotton yield prediction (Gupta and Singh, 1990). The study presented here is to see how different climatic variables affect the crop yield during crop growing season. Correlation study for a week period gives a preliminary idea about the effect of any particular weather variable on the yield during that week.

MATERIALS AND METHODS

Daily values of the meteorological elements viz., maximum and minimum temperature, maximum and minimum relative humidity, wind speed, rainfall, number of rainy days and sunshine duration were collected from Center of Dryland Agriculture Research, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Other climatic variables (Table1) that affect yield, were derived using observed meteorological parameters. Soil considered under study is alluvial soil. Pigeonpea yield (kg ha^{-1}) data for Varanasi district was collected from U.P. Crop Insurance and Statistical Department, Krishi Bhawan,Lucknow. In Varanasi, pigeonpea is

Phase	Crop stage	Standard week
1	Sowing to germination	28-29
2	Germination to tillering (first branching stage)	30-48
3	Tillering to flowering (second branching)	49-52
4	Flowering to seed formation	1-9
5	Seed formation to maturity	10-15

sown in 28th week (9-15th July). Total duration of crop varies from 275-285 days. The crop period is grouped into five phases as presented above.

Stepwise Regression Technique

Correlations were worked out for meteorological variables with yield on weekly basis as well as for an overlapping period of seventeen weeks. Variables having maximum simple correlation coefficeint with yield were selected for inclusion in regression. If a selected variable fail to satisfy the specified statistical level of significance it is dropped from the set.This process continues till all the significant variables are entered in the regression. The final equation thus obtained is used for prediction purpose. Three years of data set were kept aside for verification of the stepwise regression.

RESULTS AND DISCUSSION

Seventeen variables have been subjected to stepwise regression analysis (Table1) out of which only eight variables are retained in the final equation given below. The values within the paranthesis represent the 't-value'.

$$S = 1022.19 + 101.75\ TMX + 21.02\ RNG - 19.70\ MXR - 28.78\ TRN + 40.71\ NRD - 61.18\ SUN - 52.07\ PET + 21.06\ DEF$$

(4.25) (1.61) (4.25) (3.25) (4.32) (1.77) (1.96) (3.11)

where,

S is pigeonpea yield (Kg ha^{-1})

TMX is average maximum temperature (°C) of the 51st to 4th standard week (SW)

RNG is average temperature range (°C) of 49th to 51st SW

MXR is average maximum relative humidity (%) of 41st to 42nd SW

TRN is average weekly total rainfall (mm) of 43rd to 45th SW

NRD is average total weekly number of rainy days of 40th to 3rd SW

SUN is sunshine duration (hr day^{-1}) of the 4th SW

PET is potential evapotranspiration (mm) of the 49th SW

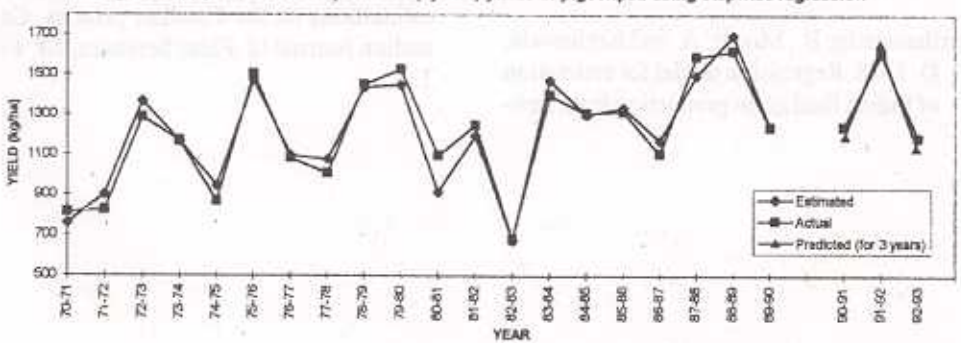
DEF is water deficit (mm) of 4th SW.

The yield variation in pigeonpea explained by weather variables is 94% which is significant at 0.1% level. The partial regression coefficients are significant at 10% level or higher. Actual, estimated and predicted yields are shown in Figure 1 which shows that the actual and estimated yields are in good agreement. The estimated yields are within 6.5% of the actual yields. The predicted yields for the test years 1990-91, 1991-92 and 1992-93 are 1244,1608 and 1190 kg ha^{-1} against the actual yields of 1189, 1665 and 1117 kg ha^{-1} respectively. These are also within 7% of the actual yield. For the minimum yield reported

Table 1: Highest correlation values of individual climatic variables with Pigeonpea yield

Climatic variables		Correlation coefficients	Standard weeks
Maximum temperature	(TMX)	0.409	51-4
Minimum temperature	(TMIN)	0.494	35
Mean temperature	(AVT)	-0.457	41-42
Temperature range	(RNG)	0.552	49-51
Maximum relative humidity	(MXR)	-0.450	41-42
Minimum relative humidity	(MNR)	-0.535	4
Average relative humidity	(AVR)	-0.561	4
Weekly total rainfall	(TRN)	-0.521	43-45
No. of rainy days	(NRD)	0.562	40-3
Sunshine duration	(SUN)	0.595	4
Potential evapotranspiration	(PET)	-0.513	49
Actual evapotranspiration	(AET)	-0.541	38
Water deficit	(DEF)	0.489	4
Moisture adequacy index	(MAI)	-0.491	4
Aridity index	(ARI)	0.493	4
Moisture index	(MOI)	-0.493	4
Modified moisture index	(MMO)	-0.516	43-46

Fig. 1 Actual, estimated and predicted (3years) yields of pigeonpea using stepwise regression



in the year 1982-83, the prediction of the stepwise regression model is also in good agreement with the actual.

The prediction equation developed by stepwise regression technique successfully estimates the pigeonpea yield with 94% accountability in Varanasi district. During the year of extremely low production also model is capable to estimate with fairly good accuracy. Thus the study indicates that the prediction equation may be used to estimate the pigeonpea yield well before maturity. Moisture related parameters during the 4th standard week related to seed formation stage are significant in determination of grain yield.

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