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Original Research Article

Development of Regression Model to predict the Seed Cotton Yield with Meteorological Variables

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A B S T R A C T

The climatic factors are largely uncontrolled, the variables that influence crop production must be quantitatively evaluated if we want to explain adequately the effects of any climatic variable on cotton growth stages. Cotton (*Gossypium hirsutum* L.) is a major row crop grown primarily for fiber and seed. The study was carried out during 2015-2016 at Department of Agricultural Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani at 19^0 16' N latitude; 76^0 47' E Longitude and 409 meters above mean sea level (MSL) The historical weather data, seed cotton yield and phenological data of hybrid NHH-44 cotton variety from 1998 to 2010 was analysed. Seed cotton yield correlated with weather parameters at each phenophase showed highly negative correlation with BSS at P_7 and $P_{8,}$ minimum temperature at P_3 stage and rainfall at P_9 stage where as positive correlation with maximum temperature at P_5 and P_8 stage, rainfall at P_1 stage and minimum temperature at P_8 stage with seed cotton yield. The Regression model explains 48 percent variation in seed cotton yield due to weather parameters at different phenophases of NHH-44 hybrid.

Introduction

Cotton is the world's most important fiber crop and the second most important oil seed crop. The primary product of the cotton plant is lint that covers the seeds within the boll. Adequate soil temperature and moisture conditions at planting are necessary to ensure proper seed germination and crop emergence. The recommended soil temperature at seed depth should be above 18 °C, to ensure healthy and uniform stands (Oosterhuis, 2001). Many factors, such as length of the growing season, climate (including solar radiation, temperature, light, wind, rainfall, dew), cultivar, availability of nutrients and soil moisture, pests and cultural practices affect cotton growth (Sawan, 2012). There are various management practices that should be followed to help mitigate some of the environmental risks associated with growing of cotton. Linear regression models (Wanjura and Barker, 1985; Muhidong, 1996; Pan, 2003) were built to explain effects of climatic factors on mature cotton fiber length and strength. In India, some studies (Parthasarathy *et al.*, 1992; Kumar *et al.*, 2011) have used the simplest way of linear model wherein the meteorological factors are directly included in a linear fashion. The present attempt is based on the

correlation regression technique. The study involves seven weather parameters (maximum and minimum temperature, morning and evening relative humidity, sunshine hours, precipitation and number of rainy days on weekly basis) for developing the three different statistical models for predicting NHH – 44 hybrid seed cotton yield for Parbhani district.

Materials and Methods

Parbhani district is situated in the Godawari drainage basin in the central part of the India. The area is lying on the central part of Marathwada region in Maharashtra. Climatologically it comes under semi-arid, sub-tropical region and agro climatologically is identified as plain zone of Maharashtra. The geographic location of the VNMKV, Parbhani is 19^{o} 16' N latitude; 76^{o} 47' E Longitude; 409 meters above mean sea level (MSL) in Marathwada division of Maharashtra state. Agroclimatically Parbhani comes under assured rainfall zone. It has an average rainfall of 963 mm. The soil comes under order vertisol clay in texture medium to deep black (Inceptisol-75% / Vertisol-25). The major soils of the district are derived from "Deccan trap" rock (basalt) which is rich in iron, lime and magnesium (Gajbe *et al.*, 1976). The total surface area occupied by the Parbhani district is 6511.58 km^2.Phenological and corresponding seed cotton yield data of cotton crop was collected from Department of Agricultural Meteorology, V.N.M.K.V., Parbhani. This data was obtained from 1998 to 2010 for NHH-44 hybrid as per availability.

Statistical and economic analysis has been carried out using Statistical Package for social Sciences (IBM-SPSS). Karl Pearson's coefficient between weather parameters *viz*., maximum temperature, minimum temperature, rainfall and sunshine hours was worked out. The data were suitably illustrated with graphs and figures at appropriate places. The statistical correlation coefficients between seed cotton yield and climatic variables namely rainfall, temperatures and bright sunshine hours according to phenophases was worked out using Pearson's coefficient formula given by;

$$r_{xy} = \frac{\left|\sum xy - \frac{\sum x \sum y}{n}\right|}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)\left(\sum y^2 - \frac{(\sum y)^2}{n}\right)}}$$

Where,

r = correlation coefficient
x = weather parameter
y = cotton yield
n = number of years

The regression analysis was done to obtain a regression equation based on the phenological phases with weather parameter of the crop. The regression equation will used to predict seed cotton yield. Thus influence of independent variable was worked out by using the equation:

$Y= a+b_1X_1P_1+b_2X_2P_2+\ldots\ldots\ldots\ldots + b_n X_nP_n$

Where,

Y = Dependent variable

X = Independent variable (weather parameter)

P = Independent variable (Phenophases)

b = Partial regression coefficient

a = Constant

n = Total number of variables

Results and Discussion

The year wise phenophases of cotton crop variety (NHH-44) and weather parameters (rainfall, maximum temperature, minimum temperature and bright sunshine hours) were correlated with seed cotton yield for Parbhani district. Tables are arranged according to the phenological stages with weather parameters of Cotton crop along with seed cotton yield observed during year 1998 - 2010 (As per data available). Out of all the periods, the sensitive periods of statistical and phenological significance were selected for Parbhani district.

Rainfall was positively correlated with seed cotton yield at P_1 (0.291*) stage in respect of NHH-44 cultivar while P_9 (-0.375**) stage was highly negatively correlated and remaining stages of cotton crop were positively correlated except P_5 stage. However, the relationship was not significant (Table 1).

Maximum temperature was positively correlated with seed cotton yield at P_5 (0.291*) and P_8 (0.296*) stage in respect of NHH-44 cultivar and remaining stages of cotton crop were positively not significant except P_6 and P_9 stage had negative relationship (Table 1).

Minimum temperature was positively correlated with cotton seed yield at P8 (0.344*) stage in respect of NHH-44 cultivar and P_9 (-0.305*) stage was negatively correlated and highly negatively correlated at P_3 (-0.387**) stage remaining stages of cotton crop had been negatively not significant except P_7 stage had positive relationship (Table 1).

BSS had been highly negatively correlated with seed cotton yield at P_7 and P_8 stages (0.484**) and (0.382**), respectively also negatively correlated at P_6 stage (-0.288*) in respect of NHH-44 cultivar and remaining stages of cotton crop were negatively or positively not significant or vice-versa (Table 1). Similar result was reported by Sawan Zakira (2012).

Emmanual and Johnson (2013) reported that minimum temperature exhibited negative correlation and was found to be statistically significant at planting to leaf development stage.

It means that rainfall at P_9 stage, bright sunshine hours at P_7 and P_8 stage and minimum temperature at P_3 stage are most important seed cotton yield contributing weather parameters in Cotton crop.

The variation in productivity might be due to changing cropped area under crop as well as due to the seasonal weather conditions.

The resultant multiple regression equation was derived and expressed as

$$Y = 2458.925 - 176.344\ X_1\ P_7 - 81.455\ X_2\ P_3 - 11.150\ X_3\ P_9 + 58.674\ X_4\ P_5$$

$$R^2 = 0.48$$

Where,

Y = Dependant variable (Seed Cotton Yield)

$X_1\ P_7$ = BSS at boll bursting to 1st picking

$X_2\ P_3$ = Minimum temperature at seedling stage to square formation

$X_3\ P_9$ = Rainfall at 2nd picking to 3rd picking

$X_4\ P_5$ = Maximum temperature at flowering to boll formation

R^2 = Regression Coefficient

Table.1 Correlation co-efficient exhibited by weather parameters prevailed in different phenophases with seed cotton yield (NHH-44) of Parbhani district during 1998-2010

NHH-44 (1998-2010)									
Parameters	**P_1**	**P_2**	**P_3**	**P_4**	**P_5**	**P_6**	**P_7**	**P_8**	**P_9**
Rainfall	0.291*	0.128	0.149	0.155	-0.215	0.210	0.214	0.201	-0.375**
T.max	0.202	0.243	0.123	0.129	0.289*	-0.103	0.112	0.296*	-0.150
T.min	-0.137	-0.024	-0.378**	-0.176	-0.076	-0.015	0.057	0.344*	-0.305*
BSS	-0.125	-0.270	-0.098	-0.003	0.040	-0.288*	-0.484**	-0.382**	-0.140

***** = Significant at 5% level, ****** = Significant at 1% level

Whereas,

P_1 - Sowing to emergence
P_2 - Emergence to Seedling
P_3 - Seedling stage to square formation
P_4 - Square formation to flowering
P_5 - Flowering to Boll formation
P_6 - Boll formation to boll bursting
P_7 - Boll bursting to 1st picking
P_8 - 1st picking to 2nd picking
P_9 - 2nd picking to 3rd picking

Table.2 Regression equation for different phenophases and seed cotton yield of hybrid NHH-44 in Parbhani district during1998-2010

Sr. No.	Phenophases	Parameters	Regression Coefficients	R^2
1	P_7	BSS (hrs)	-176.344	0.48
2	P_3	Tmin (^{0}C)	-81.455	
3	P_9	RF (mm)	-11.150	
4	P_5	Tmax (^{0}C)	58.674	

Where,

P_3 = Seedling stage to square formation
P_5 = Flowering to Boll formation
P_7 = Boll bursting to 1st picking
P_9 = 2nd picking to 3rd picking

The equation indicated that weather parameters such as minimum temperature at seedling stage to square formation stage, Bright sunshine hours at boll bursting to 1st picking stage and Rainfall at 2nd picking to 3rd picking stage showed negatively significant relationship, while maximum temperature at flowering to boll formation stage showed positively significant effect on seed cotton yield. The regression equation obtained showed R^2 value = 0.48. This implies that about 48 % of variation in seed cotton yield with weather parameters such as minimum temperature, maximum temperature, rainfall and bright sunshine hours at different phenophases

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