# INFLUENCE OF WEATHER PARAMETERS ON THE YIELD OF BLACK PEPPER

By

DESSY MABEL

**THESIS**

Submitted in partial fulfilment of the requirement for the degree

**Master of Science (Agricultural Statistics)**

Faculty of Agriculture
Kerala Agricultural University

Department of Agricultural Statistics
COLLEGE OF HORTICULTURE
Vellanikkara, Trichur

1990

*To my husband*

# DECLARATION

I hereby declare that this thesis entitled "INFLUENCE OF WEATHER PARAMETERS ON THE YIELD OF BLACK PEPPER" is a bonafide record of research work done by me during the course of research and that the thesis has not been previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Vellanikkara,
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CERTIFICATE

Certified that this thesis, entitled "INFLUENCE OF WEATHER PARAMETERS ON THE YIELD OF BLACK PEPPER" is a record of research work done independently by Smt. DESSY MABEL, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

VELLANIKKARA,
3-1-1990.

V.K.GOPINATHAN UNNITHAN
(CHAIRMAN, Advisory Board)
ASSOCIATE PROFESSOR OF AGRL. STATISTICS
COLLEGE OF HORTICULTURE

## ACKNOWLEDGEMENT


With immense pleasure, I express my deepest sense of gratitude and indebtedness to Sri.V.K. Gopinathan Unnithan, Associate Professor of Agricultural Statistics and Chairman of the Advisory Committee for his inspiring guidance and co-operation in the preparation of the thesis.

I place on record my indebtedness to Dr.K.C. George, Professor and Head of the Department of Statistics, College of Veterinary and Animal Sciences for his constant encouragement and help rendered.

I wish to thank Dr.P.B. Pillai, Professor, Agri-meteorology, College of Horticulture, Vellanikkara for his advice during the study period.

Profound thanks are also due to Sri.V. Sukumara Pillai, Professor, Pepper Research Station, Panniyoor, for the supply of necessary data and for his advice and help.

I extend my sincere thanks to the staff and students, Department of Statistics, College of Veterinary and Animal Sciences and College of Horticulture.

I express my sincere thanks to the Dean, College of Veterinary and Animal Sciences and Associate Dean, College Horticulture for providing the necessary facilities.

I am grateful to the Kerala Agricultural University financial assistance in the form of fellowship.

Lastly, but never the least, I here record my heartfelt gratitude and high indebtedness to all my beloveds especially my parents and my husband Mr. Cheriyan Joseph, for their constant encouragement, unflagging interest and support in completing the research programme.

DESSY MABEL

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## GLOSSARY OF SYMBOLS

| | |
|---|---|
| MNT | Minimum temperature |
| MXT | Maximum temperature |
| NR | Number of rainy days |
| RF | Rainfall |
| RH | Relative humidity |
| T | Trend |
| $Z_{MN}$ | Regression estimate of yield with minimum temperature of fortnights as predictor variables |
| $Z_{MN.1}$ | Regression estimate of yield with minimum temperature in first group of standard weeks (April to June) as predictor variables |
| $Z_{MN.2}$ | Regression estimate of yield with minimum temperature in the second group of standard weeks (June to August) as predictor variables |
| $Z_{MX}$ | Regression estimate of yield with maximum temperature of fortnights as predictor variables |
| $Z_{MX.1}$ | Regression estimate of yield with maximum temperature in the first group of standard weeks as predictor variables |
| $Z_{MX.2}$ | Regression estimate of yield with maximum temperature in the second group of standard weeks as predictor variables |
| $Z_{NR}$ | Regression estimate of yield with number of rainy days of fortnights as predictor variables |
| $Z_{NR.1}$ | Regression estimate of yield with number of rainy days in the first group of standard weeks as predictor variables |
| $Z_{NR.2}$ | Regression estimate of yield with number of rainy days in the second group of standard weeks as predictor variables |

| | |
|---|---|
| $Z_{RF}$ | Regression estimate of yield with rainfall of fortnights as predictor variables |
| $Z_{RF.1}$ | Regression estimate of yield with rainfall in first group of standard weeks as predictor variables |
| $Z_{RF.2}$ | Regression estimate of yield with rainfall in second group of standard weeks as predictor variables |
| $Z_{RH}$ | Regression estimate of yield with relative humidity of fortnights as predictor variables |
| $Z_{RH.1}$ | Regression estimate of yield with relative humidity in first group of standard weeks as predictor variables |
| $Z_{RH.2}$ | Regression estimate of yield with relative humidity in second group of standard weeks as predictor variables |

# Introduction

# INTRODUCTION

Though man has no control over climatic factors, adequate knowledge of the influence of these factors on crops helps to derive maximum benefit through planned measures.

Weather is a major factor influencing growth, sustenance and yield of any crop. It controls every phase of agricultural activity. A knowledge of the risk due to adverse weather conditions such as drought, flood, frost and environmental conditions conducive to pest and disease incidence, is of vital importance for proper planning of production and distribution of crops.

Forecasting yield of agriculture crops is of prime importance to the nation. It helps to estimate production of the crop well ahead of harvest in a particular season. Such estimates are essential for proper planning of distribution of food and other relief measures in areas with impending crop failure, for determination of the quantity of food to be purchased in the case of expected shortage and aiding with decisions regarding withdrawals and additions to national food resources.

Crop-weather models are practical research tools for the analysis of crop response to weather and climatic variations. A crop-weather model may be defined as simplified representation of a complex relationship between weather or climate on one hand and crop performance such as growth, yield or yield components on the other hand by using established mathematical or statistical techniques.

Although there are numerous studies utilizing the linear, curvilinear and multiple regression techniques, we are still in the dark as regards the exact manner in which various weather elements influence and control crop growth and the resulting yield.

It is very seldom that a single weather factor accounts for all of the variations in the performance of a crop. Hence multiple linear regression analysis is in wide use for crop-weather models. The predictability of such models increases with increase in the number of explanatory variables at the expense of simplicity and hence practical utility. Therefore utmost care has to be taken in developing the forecasting models with a large number of weather elements.

## 1.1. Pepper and weather

Pepper (Piper nigrum L) is most important of all spices and is popularly known as the king of spices. The pepper plant is a native of Kerala. It originated in the evergreen forests of the Wester Ghats and exhibit several peculiarities morphologically and histologically.

Pepper required a fully tropical climate and rainfall of at least 1500 mm and a humid warm atmosphere. The crop stands a fairly wide range of temperature as the average of the daily maximum temperature may go up to 38°C and the minimum to an average of 16°C with about 10°C as the lowest. As regards altitude, pepper can be grown from sea level up to elevation of 1220 metres. The soil on which the crop is grown are the red loams and sandy loams and largely lateritic in type. It is grown in situations where there is no lack of drainage on the slopes and elevated levels.

Pepper is a major foreign exchange earner for India and India is a major exporting country of pepper. Pepper is produced mainly in India, Indonesia, Malaysia, Brazil and Sri Lanka. These countries account for more than 95% of the world production. Though India has over 50% of total area under pepper in world, it accounts only less than 30% of the production. The all India estimate of production of black pepper for the year 1987-88 was 49.23 thousand tonnes. The area under the crop was estimated at 158.49 thousand ha in 1987-88 (George, 1989). Kerala state alone accounts for 96% of the area and production of this crop in the country. Thus pepper has a very important position in the economy of the state.

Pepper plant begins to yield a full crop only after the 5th or 6th year. The yield from the vines is exceedingly variable both on account of the varieties that usually comprise the garden and on account of seasonal variations.

This crop is known to be very sensitive to climatic parameters especially the pattern of rainfall. The performance of the crop is highly dependent on the quantity and distribution of rains. This is mainly because of the influence of the moisture regime (both in the soil and atmosphere) on the various stages of the sexual phase of the plant, starting from flower bud differentiation to pollination and berry development.

So far, no serious attempt has been made to extract information on the different stages at which the weather elements influence the yield of pepper and their extent of influence. Therefore the present study was undertaken with an objective of assessing the influence of weather elements at various periods on the yield of black pepper and developing yield forecasting models based on the weather elements.

# Review of Literature

# REVIEW OF LITERATURE

Literature on crop-weather relationship in pepper is scanty and more so is that on yield forecasting models in this crop. Even in the case of perenial crops in general, research on the influence of various weather elements on the performance of the crop and prediction models based on weather factors have not been taken up extensively. The limited literature available are reviewed in this chapter.

## 2.1. Pepper

The flowering process in the pepper plant initiates by the application of water equivalent to 70 mm or more of rainfall within a period of 3 weeks, following a dry spell (KAU, 1953-54).

Paulose (1973b) observed that in major pepper growing areas of Kerala the annual average rainfall is over 300 cm distributed in 8 to 10 months with day temperature ranging from 28°C to 35°C.

Menon (1981) reported that extension growth of plagio tropes in pepper starts in April-May with the receipt of pre-monsoon showers and continues upto August-September.

It was also found that 82 to 83 per cent of the total annual growth of the fruiting branches register in June-July, coinciding with the peak period of monsoon. Rainfall was found to be positively correlated with flower bud differentiation process. Histological examinations revealed that flower bud differentiation starts in the shoots in April-May with the receipt of premonsoon showers and reaches a peak in June-July (Nalini, 1983).

Ibrahim et al. (1985) reported that the seasonal variation influences different varieties differently and the high yielding varieties are increasingly susceptible to climatic changes.

Pillay et al. (1988) compared the rainfall pattern and yield of pepper during the two extremely adverse years (1980-81 and 1986-87) to that of a favourable year (1981-82). It was found that during both the adverse years, there was a distinct break in the rainfall during the critical period following flower initiation. The break was experienced at two different times and therefore at different stages of the crop during the two years but in both cases, the pepper yields were low when compared to the favourable year, the rainfall remained steady without any break and the yield was high. They concluded that a break in the rainfall even for a few days at a stretch during any part of the critical period of reproductive phase of the pepper would affect the yield considerably.

2.2. Cashew

Menon (1987) fitted forecasting models for yield in cashew. Six forecasting models were developed by attributing three different weights to the general square and square root forecasting models. With an effective crop season of six months, four seasons were developed by taking different combinations of these six months period. Thus for each variety of cashew in a particular season, 6 forecasting models were developed, using the generated weather prediction variables. The final crop forecasting models were constructed using the technique of stepwise regression. Correlation of meteorological parameters with yield revealed that sunshine and temperature in November while rainfall in January were the trend setting factors of production.

2.3. Tea

In Malwi, Laycock (1958) observed that there was no correlation between annual rainfall or monthly rainfall with annual yield of tea. By splitting the year into 3 distinct parts he fitted a multiple regression equation.

$$Y = .091E + .047M + .06D + 1.79$$

where

Y - tea yield in 100 kg/ha

E - early rains (November-December)

M - Main rain (January-May)

D - when soil dry (June-December)

Dry season rain had a depressing effect on yield and early rain was found to be twice productive as the main rain.

Sen et al. (1966) correlated tea yield with climate in an unshaded area at Tocklai Research Station. The mean value of rainfall, relative humidity, sunshine hours and temperature were used as a predictor variables. Time variables were added as predictor variables for changes in the growth rate of tea plants. They split the year into four main seasons based on the relative soil moisture availability. Rainfall in the period of January to March and rise in mean temperature during the same time were found to have greatest influence on early crop, which in turn led to an increase in main crop. April to June rainfall was found to depress the late crop while during October-December it was beneficial.

An emperical expression for the tea yield was proposed by Devanathan (1975) which relates vegetative growth to the product of rainfall and bright sunshine hours over a specified period. The prediction equation was

$$Y = 0.255\ RS - .87 \qquad r = .97$$

where Y - the expected yield

R - Rainfall in the specified period

S - Sunshine hours in the period

Mustaffi and Chaudhari (1981) attempted to predict tea crop yield in Danguajhar tea estate, Jalpaigari, West Bengal on the basis of data on monthly green tea leaves production, monthly rainfall and Penman's evaporation records. This involved in expressing the crop production process as a function of the past values of monthly tea crop production and also of both past and current values of the meteorological parameters. Ivakhnanko's Multilayer groups Method of Data Handling (GMDH) was used to estimate production model. The process can be described by $\phi = f(x_1, x_2 \ldots. x_n)$ and it involves the construction of several layers of partial descriptions. Using two input variables at a time 1st layer can be represented by $Y_i = f(x_j, x_k)$ for $j = k = 1, \ldots n$ $j \neq k$ and $i = 1, 2 \ldots m$ where $m = \binom{n}{2}$. Second layer can be represented $Z_{i'} = g(y_{j'}, y_{k'})$ for $j' = k' = 1, \ldots m$ $(j' \neq k')$ and $i' = 1, 2 \ldots p$ where $p = \binom{m}{2}$ m and p are the number of pairwise combination of first and second layers respectively. The first step concerns the selection of input variables on the basis of strong correlation.

## 2.4. Coconut

Patel and Anandan (1936) investigated the influence of rainfall on yield of coconut and reported that the crop yield in a particular year is influenced by January to April rains of the two years previous to the year of harvest together with the rains in January-April of the year of harvest.

Balasubramanian (1956) reported that the yield of coconut was influenced by rainfall of January at North Kanara district, of February at Kasargod and of February and March at Pilicod and stated that the differential influence was due to the effect of soil type.

Abeywardene (1968) termed the rainfall during the critical period of crop development as effective rainfall. He developed a yield forecasting model from rainfall at critical periods of the coconut which extends over a period of three years. The model was given by

$$Y = 8.98 + 0.02\ X_1 - 0.6\ X_3 - 0.6\ X_4 + 0.13\ X_5 + 0.84\ X_6 + 0.027\ X_7 + 0.02\ X_8 + 0.03\ X_9 + 0.023\ X_{10} - 0.013\ X_{11} + 0.048\ X_{12} \qquad R^2 = .873$$

where

$Y$ - the estimated yield of coconut

$X_1$ - May-August rainfall (two years prior)

$X_2$ - January-April previous year

$X_3$ - May-August previous year

$X_4$ - September-December previous year

$X_5$ - September-December to year prior

$X_6$ - January-May of harvest year

$X_7$ - Product of $X_1$ and $X_4$

$X_8$ - Product of $X_2$ and $X_4$

$X_9$ - Product of $X_2$ and $X_3$

$X_{10}$ - Product of $X_3$ and $X_5$

$X_{11}$ - Product of $X_5$ and $X_6$

$X_{12}$ - Previous years rainfall with an effective monthly maximum of 12.5 cm of rainfall

Rao (1984) estimated the relationship between annual coconut yields and annual rainfall using 20 years of data from Pilicode region. He concluded that both high rainfall during the month of June, July and August as well as absence of pre and post monsoon showers adversely affected the subsequent years coconut yield.

Nair (1985) reported the influence of pre and post monsoon showers on the coconut yield of subsequent years. He developed a number of forecasting models for coconut yield using step-wise regression. The model for annual coconut yield estimated from month-wise climatic factors was

$$Y = -.0518\ X_1 + .1177\ X_2 - .079\ X_3 - .0621\ X_4 + .1159\ X_5 - .388\ X_6 - .189\ X_7 + 20.68 \qquad R^2 = .853$$

where

$Y$ - the expected yield of coconut

$X_1$ - Relative humidity in September

$X_2$ - Evaporation in July

$X_3$ - Range in soil temperature (15 cm) in April

$X_4$ - Range in soil temperature (15 cm) in December

$X_5$ - Sunshine hours in May

$X_6$ - Sunshine hours in December

$X_7$ - Pre-yield

He also developed a model using the climatic factors in 12 seasons prior to harvest. (Each year is divided into four seasons Season I - December, January and February. Season II - March, April and May Season III - June, July and August Season IV - September, October and November). The second stage model obtained was

$$Y = .5972\ \text{RHAN} + .4867\ \text{SSH} - .6643 \qquad R^2 = .914$$

Y - the square root of the estimated annual yield

$$\text{RHAN} = -.1031\ X_2 - .1477\ X_4 - .0389\ X_8 + .0611\ X_9 - .078\ X_{11} + 24.22$$

$X_i$ is the relative humidity in the season, i + 3 seasons prior to the harvest year

$$\text{SHAN} = .3263\ X_2 + .5076\ X_{12} - .754\ X_9 - .229\ X_6 - .2521\ X_7 + .2645\ X_{10} + .2415\ X_8 - .1946\ X_4 + .2279\ X_1 + .6713$$

$X_i$ is the sunshine hours in the season i + 3 seasons prior to the year of harvest.

Swe (1985) estimated yield forecasting models for coconut from weather parameters of quarterly as well as half yearly periods of the effective crop season which extend from the month just before harvest to 36 months before harvest. He used step-wise regression to estimate the final model with generated weather variables as predictor variables.

2.5. Oil palm

Devuyst (1948) reported positive correlation between annual yield and the sum of monthly rainfall upto 300 mm during the consecutive 12 months as well as 33 months before harvest. Hemptinne and Ferwerda (1961) reported negative correlation of bunch yield with precipitation during the month which is 31 months prior to harvest and possitive correlation with that during the month which is 12 months prior to harvest in northern region in West Africa and a quadratic relationship with precipitation of 33 months earlier to harvest in the southern region.

Sparnadji _et al_. (1967) observed positive correlation between sunshine hour per annum and bunch yield.

Robertson and Foong (1976) observed that solar radiation was least influential on the yield of oil palm.

# Materials and Methods

# MATERIALS AND METHODS

## 3.1. Materials

Materials for this investigation consisted of annual yield data for 29 varieties of pepper for the period from 1963-64 to 1979-80 taken from the field records of The Pepper Research Station, Kerala Agricultural University, Panniyoor along with daily weather data on maximum temperature, minimum temperature, relative humidity, rainfall and number of rainy days for the same period recorded at the same station. The yield was recorded in Kg and were averages of five vines for every variety.

Weather data during 1976 and 1977 were missing in the field records and hence the corresponding yield data were also omitted for the analysis. Thus data on yield and weather for 15 years were utilised for this investigation.

The Pepper Research Station, Panniyoor is situated in Cannanore District of Kerala State, at a latitude of 12° 05' N and longitude of 75° 23' E.

The daily observations on weather elements were converted to weekly data according to standard weeks

(Appendix I). In the case of rainfall and number of rainy days, weekly totals were considered, while for all other parameters weekly averages were taken.

The weekly weather data were converted to that of fortnight by averaging the weekly weather data of two consicutive weeks for all weather parameters except for rainfall and number of rainy days. For these two weather parameters, weekly data of two consicutive weeks were added.

The data were entered into the computer system (HCL - work horse) available at the College of Horticulture, Kerala Agricultural University, Vellanikkara, Kerala and were verified.

## 3.2. Methods

In the life span of a crop it is noticeable that weather variables have profound influence on its yield and affects it differently at different stages of development. The impact depends on both the magnitude and distribution of weather variables over the crop season.

These conditions necessiate the division of the crop season into effective and non effective crop seasons.

An effective crop season is defined as the length of the time interval during which the weather variables are considered to have significant influence on the crop yield.

In pepper the period from flower initiation to early berry development was reported to be the critical period which extends over 110-120 days (Pillay _et al._, 1988). Menon (1981) and Nalini (1983) reported that extension growth of plagiotropes starts in April-May with the receipt of premonsoon showers and continue upto August-September. Flowering was found to be initiated by the application of water equivalent of 70 mm or more within a period of three weeks following a dry spell (KAU, 1954).

Thus the critical period in the reproductive phase of the plant was identified as 18 weeks which starts from 15th standard week and ends in the 32nd standard week. Weekly as well as fortnightly data were used for the analysis.

### 3.2.1. Coefficients of correlation

Coefficient of correlation is a measure of intensity or degree of linear relationships between two variables.

In order to study the relationship between the weather parameters, at different lag periods and the yield of pepper, simple correlations were worked out between each of the five weather variables of every standard week and fortnight with annual yield of all the 29 varieties of pepper.

3.2.2. Correlogram

With a view to study the hidden pattern of relationship between the yield and weekly weather variables in the critical period, correlograms were drawn for, five selected common varieties and all the five weather parameters.

The yield forecasting models for the 29 varieties were estimated in two stages.

3.2.3. First stage models

Each weather parameter for a standard week or a fortnight was considered as a variable in the respective model. Consequently a very large number of explanatory variables had to be considered. Therefore these variables were grouped into ten in the case of weekly data and five in the case of fortnightly data.

For the weekly data the grouping was done as fallows. Observation on each weather parameter from 15th standard week to 23rd standard week (April 9 to June 10) were considered as one group. Thus there were five sets of variables belonging the first group of standard weeks. Similarly five sets of variables were constituted by the five weather parameters belonging to the second group of standard weeks ie. from 24th standard week to 32nd standard week. Thus there were 10 groups of variables when weekly data were considered.

In the case of fortnightly data each weather parameter for the nine fortnights of the critical period was considered as one set of variables. Thus there were five sets of weather variables for the fortnightly data.

Multiple regression of the annual yield of pepper on the weather elements in each set of variables was estimated for all the 29 varieties under consideration both for the weekly as well as fortnightly weather data.

The first stage models from weekly data were of the form

$$Z_{ij} = b_{ijo} + \sum_{k = k_{j1}}^{k_{j2}} C_{ik} X_{ik} + e_{ij} \quad (1)$$

$i = 1, 2, \ldots 5 \quad j = 1, 2 \quad k_{11} = 15 \quad k_{12} = 23$
$k_{21} = 24 \quad k_{22} = 32$

where

$Z_{ij}$ is the estimate of the yield using the $i^{th}$ weather variable in the $j^{th}$ group of standard weeks;

$b_{ijo}$ - the intercept,

$C_{ik}$ - the regression coefficient of $Z_{ij}$ on $X_{ik}$,

$X_{ik}$ - the value of $i^{th}$ weather variable in the $k^{th}$ standard week

and $e_{ij}$ - the error term.

The first stage models from fortnightly weather data were of the form

$$Z_i = C_o + \sum_{K=8}^{16} g_{ik} X_{ik} + e_i \qquad (2)$$

$Z_i$ is the estimate of the yield using $i^{th}$ weather variable

$C_o$ - the intercept

$g_{ik}$ - the regression coefficient of $Z_i$ on $X_{ik}$

$X_{ik}$ - the value of $i^{th}$ weather variable in the $k^{th}$ fortnight

$e_i$ - the error term

Second stage models

The final yield forecasting model for each variety, both from the weekly as well as fortnightly data were obtained by regressing annual yield on the estimates of yield from different first stage models and the trend variable. Step wise regression was adopted to arrive at this final model.

The second stage model from weekly data is of the form

$$Y = b_o + \sum_{i=1}^{5} \sum_{j=1}^{2} b_{ij} Z_{ij} + h_o T + e \qquad (3)$$

where

$Y$ is the expected yield,

$b_o$ - intercept

$b_{ij}$ - regression coefficient of $Y$ on $Z_{ij}$,

$Z_{ij}$ - the estimate of the yield using the $i^{th}$ weather parameter belonging to the $j^{th}$ group of standard weeks,

$h_o$ - regression coefficient of $Y$ on $T$,

$T$ - the trend value and

$e$ - the error term.

The form of the second stage model from the fortnightly weather data is

$$Y = p_o + \sum_{i=1}^{5} p_i Z_i + e \qquad (4)$$

where

$Y$ is the expected yield,

$p_o$ - the intercept,

$p_i$ - the regression coefficient of $Y$ on $Z_i$,

$Z_i$ - the estimate of the yield using the $i^{th}$ weather parameter at the first stage and

$e$ - the error term.

# Results and Discussion

# RESULTS AND DISCUSSION

The coefficients of correlation between the five weather parameters of the critical period (weekly and fortnightly) and annual yield of 29 varieties of pepper were worked out and are presented in Tables 1 to 15.

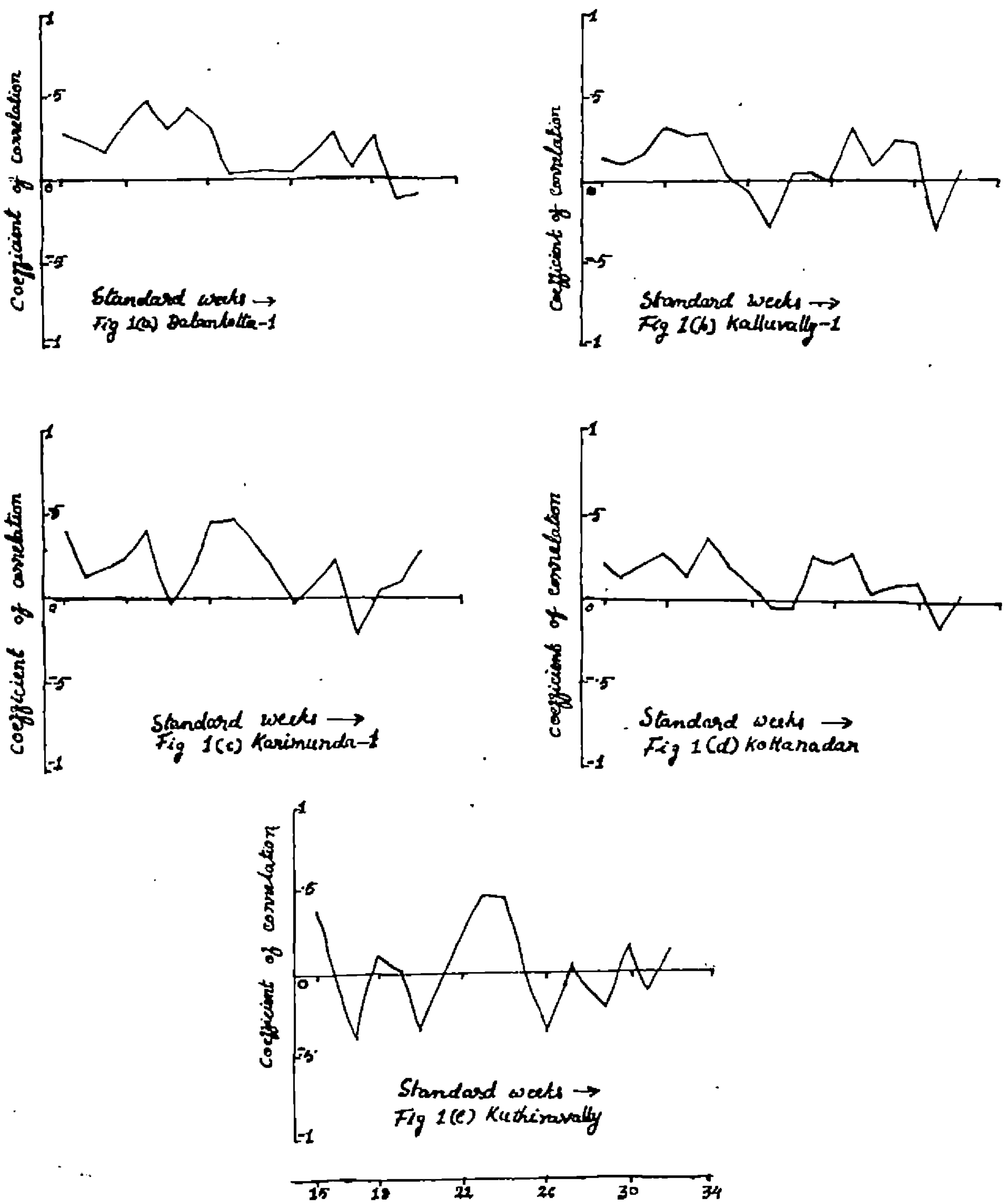
No regular pattern of the relationship of the annual yield with various weather elements at different lag weeks or lag fortnights was observed among the varieties considered. However correlograms for the annual yield and the five weather parameters of critical standard weeks were drawn for five common varieties and are shown in Fig. 1(a) to 5(e).

## 4.1. Correlogram

### 4.1.1. Maximum temperature

The correlogram of maximum temperature with yield of five selected varieties of pepper are presented in Fig. 1(a) to 1(e). It may be observed that the relationship of maximum temperature with yield has similar trend for Balamkotta I, Kalluvally and Kottanadan while that of Karimunda I and Kuthiravally have entirely opposite trend from 20th week onwards. This indicates substantial interaction of the genotypes with environment.

Correlograms for weekly maximum temperature and yield of pepper



### 4.1.2. Minimum temperature

The correlograms of minimum temperature for the five varieties during the critical periods are given in Fig. 2(a) to 2(e).

Here also the trends in relationship for the five varieties are not uniform. Similarity in trend among the varieties is not at all in the pattern for maximum temperature. Therefore it becomes almost impossible to have a grouping of varieties based on the trend in relationships of major weather elements with yield.

### 4.1.3. Relative humidity

The correlogram showing the trend in relationship of RH in the critical period with the yield of the five selected varieties are presented in Fig. 3(a) to 3(e).

It may be noted that there is cyclical pattern of relationship in the case of Kuthiravaly. The relationship is mostly negative for the other four varieties. In all cases, the relationship is positive just after the 24th standard week (June 11 to 17).

Correlograms for weekly minimum temperature and yield of pepper

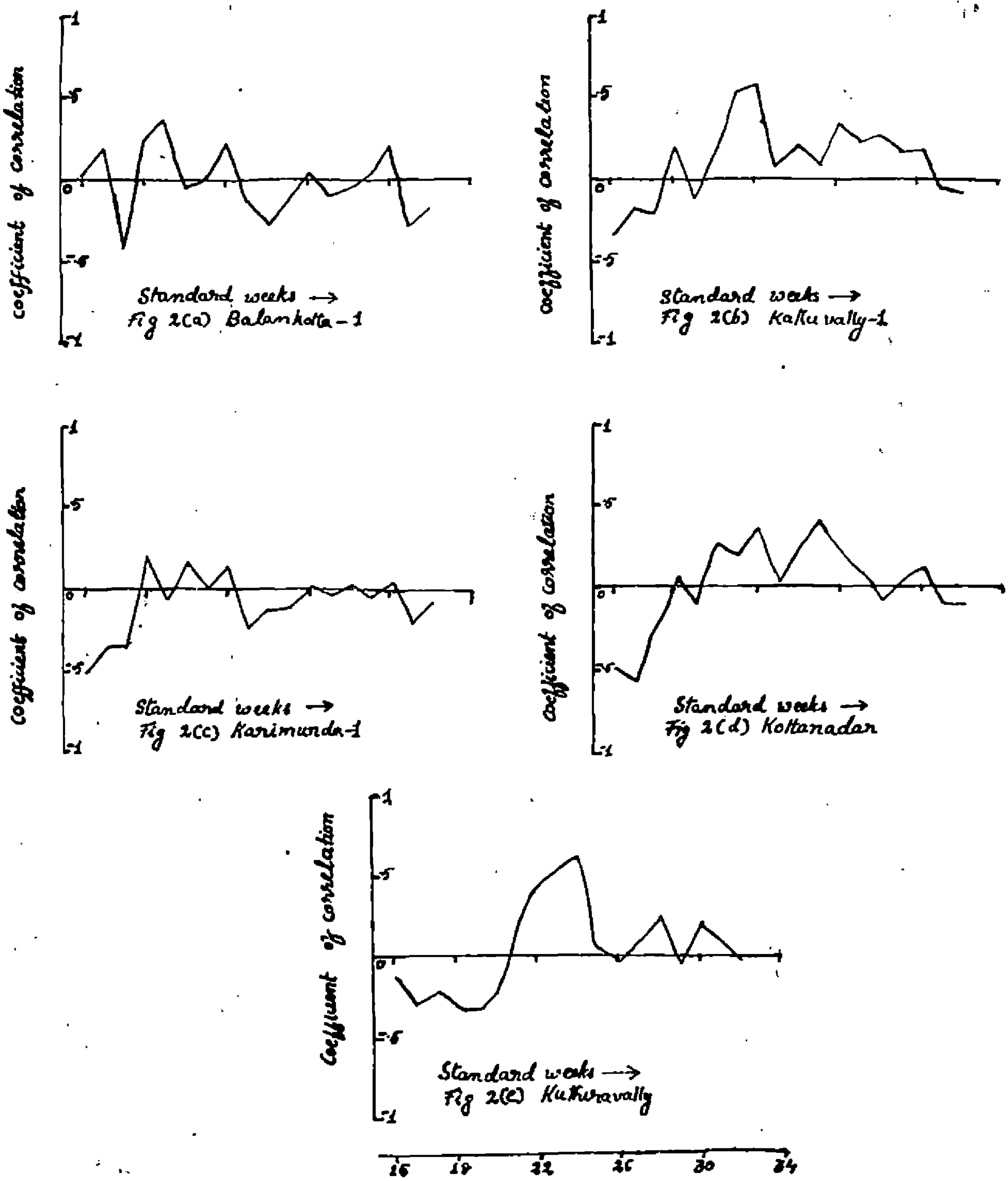



Fig 2(a) Balankotta-1

Fig 2(b) Kalluvally-1

Fig 2(c) Karimunda-1

Fig 2(d) Kottanadan

Fig 2(e) Kuthiravally

Correlograms for weekly relative humidity and yield of pepper

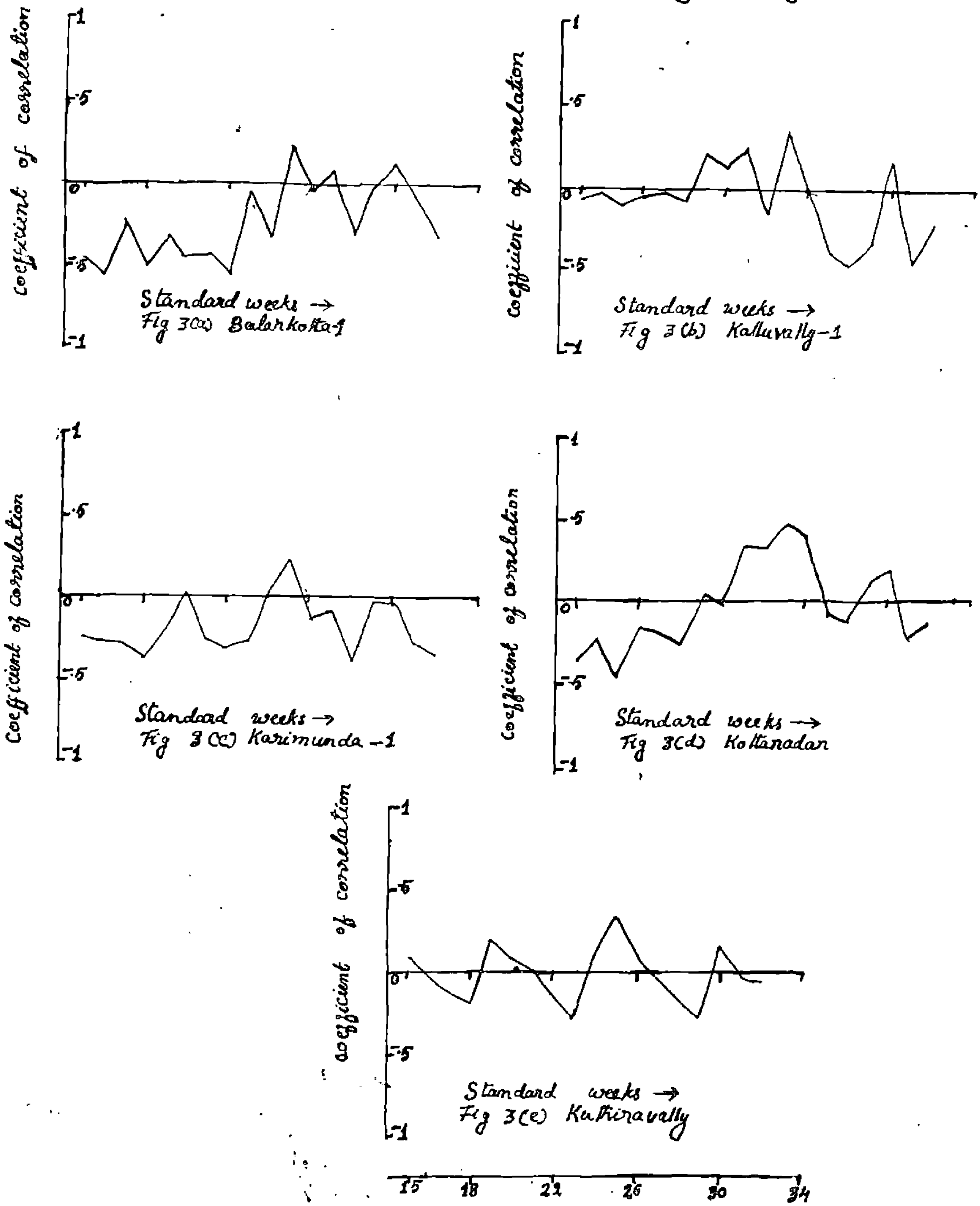



Fig 3(a) Balankotta-1

Fig 3(b) Kalluvally-1

Fig 3(c) Karimunda-1

Fig 3(d) Kottanadan

Fig 3(e) Kuthiravally

### 4.1.4. Rainfall

The correlogram of weekly rainfall and yield of five selected varieties of pepper during the critical period are given in Fig. 4(a) to 4(e).

During the 23rd week (June 4 to 10) there is high positive correlation in the case of three varieties where as for Kuthiravaly and Karimunda-I the relation is negligible and negative. This is a further evidence of interaction of genotypes with environment.

### 4.1.5. Number of rainy days

Fig. 5(a) to 5(e) represent the correlogram of number of rainy days during the critical period and yield of the five selected varieties.

Here also no similarity in trend in relationship can be observed among the varieties. Karimunda-I and Kuthiravaly have negative correlation with this character during the 22nd standard weeks while the other three have positive correlation. In fact this is the period of summer showers.

Though there is no natural grouping among the genotypes with regard to their relationship with the five

Correlograms for weekly rainfall and yield of pepper

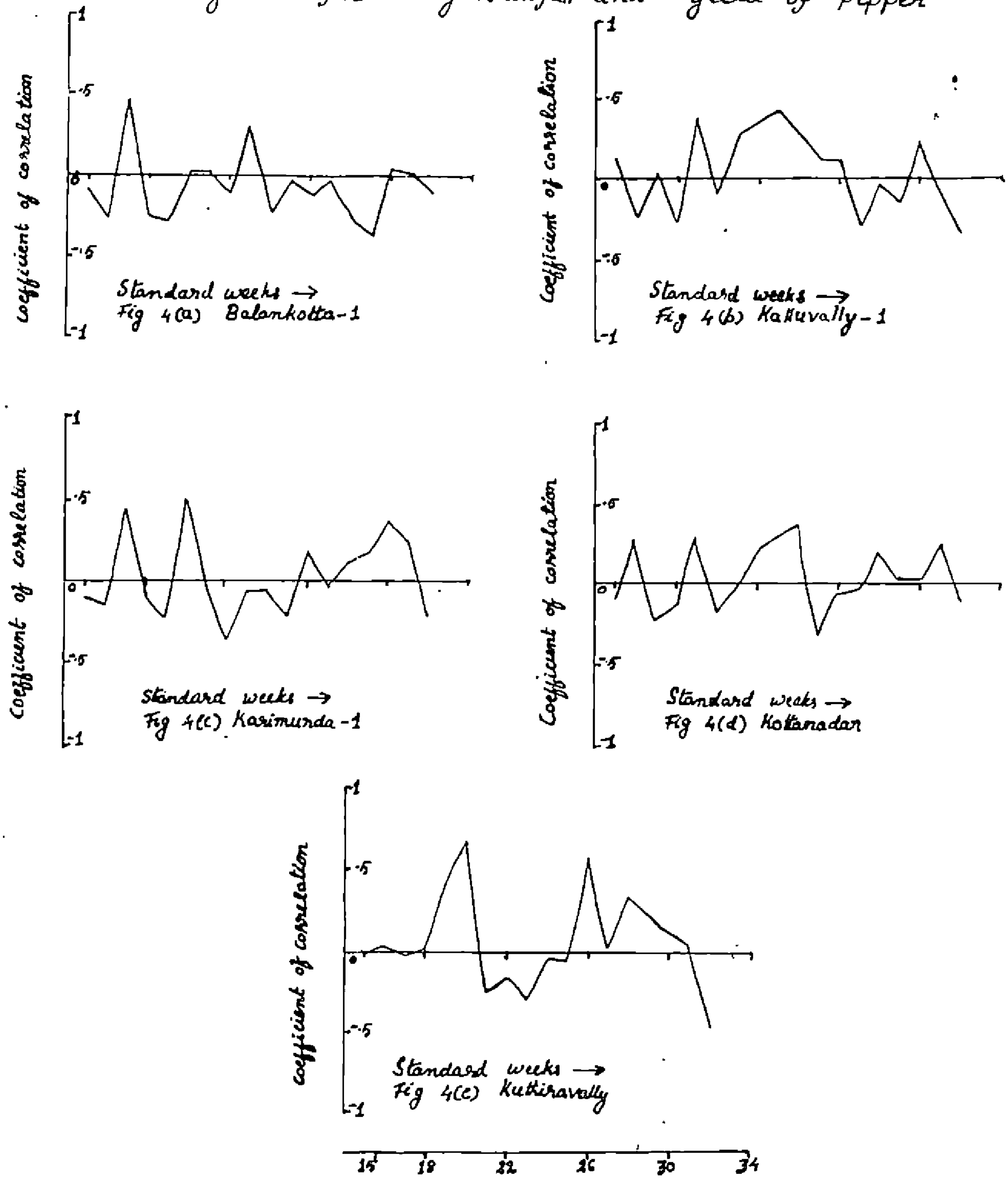



Fig 4(a) Balankotta-1

Fig 4(b) Kattuvally-1

Fig 4(c) Karimunda-1

Fig 4(d) Kottanadan

Fig 4(e) Kuthiravally

Correlograms for weekly number of rainy days and yield of pepper

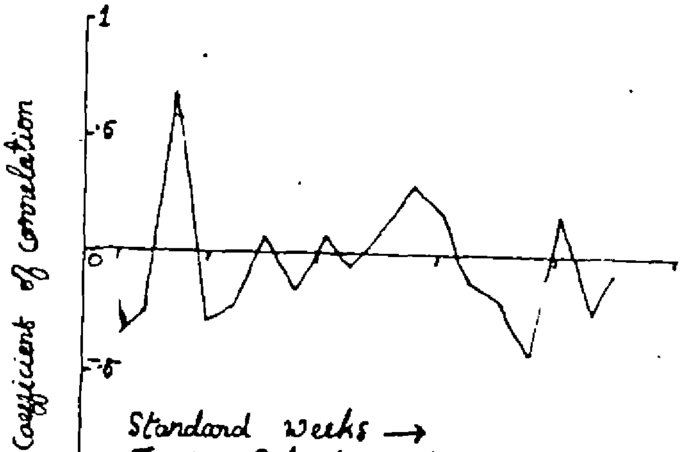



Fig 5(a) Balankotta-1

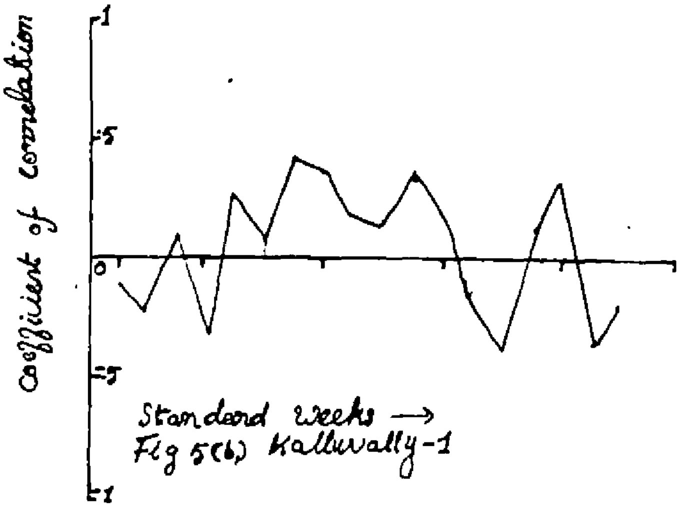



Fig 5(b) Kalluvally-1

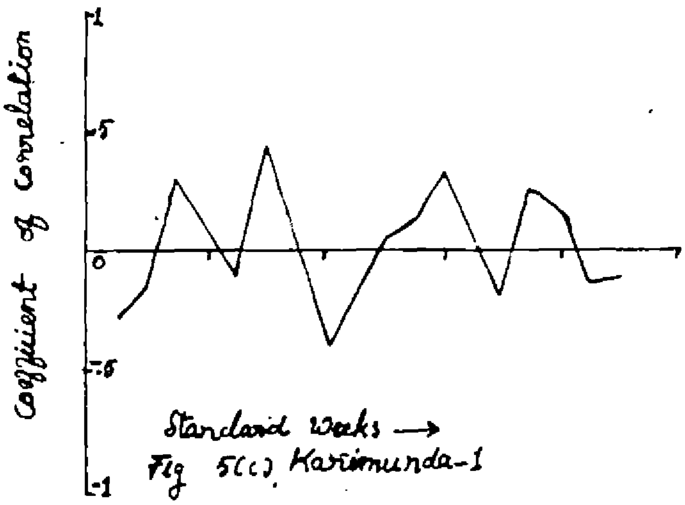



Fig 5(c) Karimunda-1

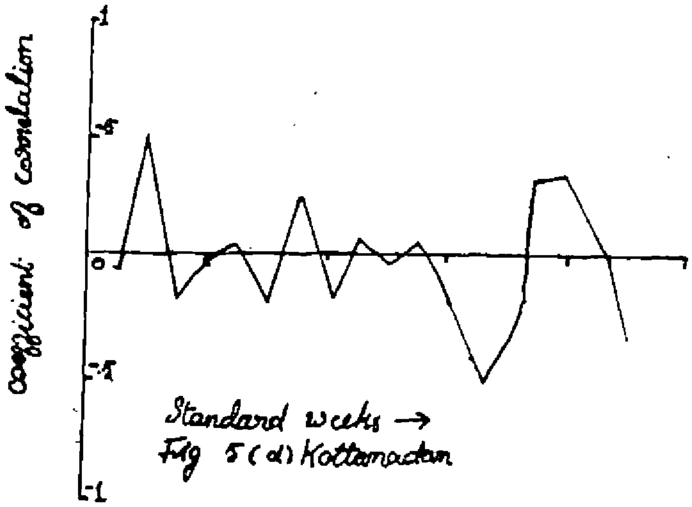



Fig 5(d) Kottanadan

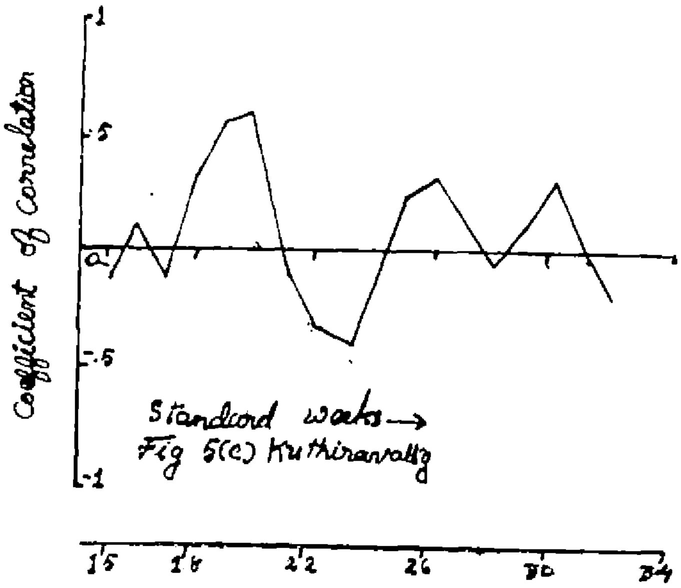



Fig 5(e) Kuthiravally

weather elements, Kuthiravaly and Karimunda-I show a response almost entirely opposite to that of Balankotta-1, Kalluvally and Kottanadan.

Two stage regression models to forecast annual yield of pepper for the 29 varieties from weather elements of standard weeks as well as of fortnights in the critical period were estimated and are presented in Tables 16 to 104.

The results obtained are explained and discussed variety by variety below:

Variety 1 - Balankotta-1

On examining Tables 1 to 10, it may be noted that the number of rainy days in the 17th standard week (April 23 to 29) had significant positive correlation with the annual yield of this variety. This period is the time when the pre-monsoon showers are received. It is quite natural that the distribution of rainfall has stronger relationship on the yield than the rainfall,and the number of rainy days is a good index of the distribution of rainfall. Relative humidity during the 16th (April 16 to 22) and 22nd (May 28 to June 3) weeks had significant negative influence on the annual yield of this variety. This could perhaps be due to the congenial atmosphere for the pathogens to rear and thereby adversely affecting the crop. No other weather variable of standard weeks in the critical period has any substantial influence on the annual yield.

When the weather elements of fortnights were considered, relative humidity during 8th fortnight alone had substantial influence on the yield and it is the fortnight corresponding to 16th standard weeks for which negative correlation with yield was obtained. No other variable of any fortnight showed any substantial influence on the annual yield when considered individualy.

The ten first stage forecasting models estimated from weekly weather elements are given in Tables 16 and 17. It is interesting to note that the model with number of rainy days from April 9 to June 10 had a predictability of 83.5%. Hence it could be stated that though the weather variables of individual weeks did not indicate substantial influence on the yield, the same variable when considered for a longer period has remarkable influence on the yield. This model itself could very well be used to forecast yield with the error in prediction being only 16.5%. This period is nothing but the period of pre-monsoon showers and it means that the annual yield of pepper gets substantial benefit from well distributed pre-monsoon showers. This type of relationship was reported by Nalini (1983).

The next model having substantial predictability at the first stage was that using relative humidity during June 11 to August 12, the coefficient of determination being .76.

Along with the ten generated variables trend was used as an explanatory variable at the second stage for step-wise regression. Five generated variables viz. $Z_{MN.1}$, $Z_{RH.1}$, $Z_{RF.1}$, $Z_{NR.1}$ and $Z_{NR.2}$ were selected as predictor variables in the final prediction model. This model could explain 98.01% of the variation in yield.

The first stage and second stage forecasting models from the fortnightly weather elements, had comparatively low predictability.

The final model from weekly weather elements had high predictability and the prediction is almost without error. It may be noted that the first stage model using number of rainy days in the first set will be quite helpful as the yield can be predicted as early as in June with relatively good predictability.

Variety 2 - Balankotta-2

Relative humidity in the 28th week (July 9th to 15) showed a significant negative correlation with the yield of this variety. This may be due to the cogenial atmosphere for the fungal diseases to affect the crop adversely. Rainfall in the 23rd week (June 4 - 10) also showed positive significant correlation with yield. This could be because the flower bud differentiation starts in the shoots in April-May with the receipt of premonsoon showers and reaches a peak in June-July (Nalini, 1983).

For the fortnightly data maximum temperature in the 10th fortnight and rainfall in the 12th fortnight had substantial influence on the yield. Both of these weather variables had significant positive correlation. Relative humidity in the 14th fortnight which corresponds to the 28th standard week had significant negative correlation with yield.

The estimated first stage prediction models from the weekly weather parameters are given in Tables 18 and 19. It is worth noting that the number of rainy days during the period from April 15th to June 10th could explain 91.2% of variation in the annual yield of this variety as in the case of Balankotta-1. This could be used as the forecasting model for this variety also and the prediction of the yield can be made as early as in the second week of June.

Minimum temperature during monsoon period (June 10 to August 12) could explain 85.2% of variation in yield response.

The final model came out with $Z_{MX.2}$, $Z_{MN.1}$, $Z_{MN.2}$, $Z_{RF.1}$, $Z_{NR.1}$ and $Z_{NR.2}$ as the predictor variables with a coefficient of determination is of 0.998. This model is capable of predicting yield very accurately.

Of the first stage models from the fortnightly weather parameters the one using relative humidity had maximum $R^2$ value of .71. The model using rainfall had $R^2$ value of .66 and that using number of rainy days had $R^2$ value of .37. The estimated second stage prediction model included four generated variables. They are $Z_{NX}$,

$Z_{MN}$, $Z_{RH}$ and $Z_{RF}$ explaining 85.2% of the variation in the annual yield (Table 104).

Here also the model using weekly weather elements is found to be having higher predictability. Moreover the first stage model with number of rainy days from April 9th to June 10th can be of advantage to predict the yield of the year as early as in the second week of June.

Variety 3 - Cheriyakaniyakadan

Number of rainy days in the 17th week (April 23 to 29) had significant positive correlation with yield. That means the premonsoon showers which is a trigering factor of flowering affect the yield of this variety very much as in the case of Balankotta-I. This result is found in agreement with the result obtained by Menon (1981). No other variable in any standard week or fortnight of the critical period showed significant correlation with annual yield of this variety.

Table 20 and 21 present the estimated forecasting models at the first stage from weekly weather parameters 88% of the variation in yield could be accounted by number of rainy days during April 9 to June 10 which can be used to forecast the annual yield. The model from minimum temperature during June 11 to August 12 also had same predictability.

Among the 10 generated variables and the trend variable, five were included in the final model. $Z_{MN.2}$, $Z_{RH.2}$, $Z_{RF.2}$, $Z_{NR.2}$ and T (trend) are the predictor variables and corresponding coefficient of determination was .9866.

Seventy nine per cent of the variation in the annual yield of this variety was accounted by relative humidity in different fortnights of critical period (Table 77). The five generated variables viz., $Z_{MX}$, $Z_{MN}$, $Z_{RH}$, $Z_{RF}$ and $Z_{NR}$ were included in the final prediction model with a coefficient of determination of .931.

Here also the model using weekly weather elements was found to be having higher predictability. The first stage model using, the number of rainy days during the premonsoon period can be used to predict the yield without much error.

Variety 4 - Chumala

It may be noted that maximum temperature in the 15th, 22nd and 23rd weeks (April 9 to 15, May 28 to June 10) and rainfall in the 18th week (April 30 to May 6) had significant positive correlation with the yield of this variety. At the same time relative humidity in the 22nd week (May 28 to June 3) and rainfall and number of rainy days in the 21st week showed significant negative correlation. The premonsoon showers during April 30 - May 6 affected the yield of this variety like other varieties. But rainfall during the 21st week had negative correlation.

Maximum temperature in the 11th and 12th fortnights which corresponds to the 22nd and 23rd standard weeks showed significant positive correlation with yield, while number of rainy days in the 11th fortnight showed significant negative correlation.

The first stage model estimated from number of rainy days of standard weeks during April 9 to June 10 had $R^2$ value of .86 and that from relative humidity during the same period had $R^2$ value of .79. As 86% of the variation in the yield could be accounted by the premonsoon showers, this model itself can be used to predict the annual yield of the variety as early as in June.

Table 74 gives estimated second stage forecasting models from weekly weather data. $Z_{MX.1}$, $Z_{MX.2}$, $Z_{MN.1}$, $Z_{RF.1}$, $Z_{NR.1}$ and T were the predictor variables that entered in the final forecasting model with a coefficient of determination of .955.

Table 78 provides the first stage regression models estimated from the weather elements of fortnights in the critical period. The model with maximum temperature in various fortnights as the explanatory variables had a coefficient of determination .82.

Finally two generated variables viz. $Z_{MX}$ and $Z_{RH}$ entered in the second stage forecasting model with $R^2$ value of .84.

Variety 5 - Kalluvally-1

For this variety minimum temperature in the 21st and 22nd weeks (May 21 to June 3) showed significant positive correlation with yield. No other weather variable of critical standard weeks had any substantial influence on the annual yield.

When the weather elements of fortnights are considered, minimum temperature in the 11th fortnight alone had substantial influence on the yield and it is the fortnight corresponding to the 21st and 22nd standard weeks for which positive significant correlation with yield were obtained.

Estimated first stage models reveal that relative humidity during the monsoon period (June 11 to August 12) alone could explain 96% of the variation in yield and 82% of the variation is accounted by minimum temperature during the same period. Prediction of yield using these models is possible only in the second week of August.

Six predictor variables were finally included at the second stage prediction model. When six generated variables are used in the prediction model the predictability is 99 per cent where as with a single generated variable (for the relative humidity of the second half of the critical period) the prediction model had a predictability of 96 per cent. Hence for all practical purposes, the first stage prediction model using relative humidity of the second group of standard weeks can be made use of.

It is worth mentioning the superiority of the prediction model using weekly weather data over that using fortnightly data. Even with a single weather element from the second group of standard weeks, 96 per cent predictability could be obtained where as, all the fortnightly data during the entire critical period could account only 84 per cent predictability.

Variety 6 - Kalluvally-2

For this variety relative humidity and number of rainy days in the 28th week (July 9 to 15) and number of rainy days in the 31st week (July 30 to August 5) showed significant negative correlation with the yield of this variety. This could perhaps be due to the congenial atmosphere for the incidence of diseases and thereby adversely affecting the crop. Rainfall in the 23rd week (June 4 to 10) showed positive significant correlation.

For the fortnightly data, relative humidity in the 14th and 15th fortnights and number of rainy days in the 14th and 16th fortnights showed substantial negative influence on the yield.

The estimated first stage regression models from weekly weather parameters are given in Tables 26 and 27. It is interesting to note that relative humidity during April 9 to June 10 alone could explain 98 per cent of the variation in the yield and maximum temperature during the same period could account for 91 per cent of variation.

The final model came out with $Z_{NX.2}$, $Z_{MN.1}$, $Z_{MN.2}$, $Z_{RH.2}$ and $Z_{RF.2}$ as the predictor variables with a coefficient of determination .996. That is, the prediction is almost with out error.

Though forecasting model using weekly weather data has a predictability of 99.6 per cent, that using the RH in the first half of the critical period alone is quite satisfactory as it has a predictability of 94 per cent and the prediction can be made as early as in the second week of June. With six generated variables making use of weather elements of all the critical period, the increase in predictability is only very marginal.

Among the first stage models from the fortnightly weather parameters the one using relative humidity had maximum $R^2$ of .93, same as in the case of Balankotta-2.

The second stage model with $Z_{RH}$ and $Z_{NR}$ as predictor variables had predictability 95.6 per cent.

Variety 7 - Kalluvally-3

For this variety rainfall in the 19th week (May 7 to 13) showed significant positive correlation while maximum temperature in the 31st week (July 30 to August 5) showed significant negative correlation. Rainfall in the 19th week is nothing but premonsoon showers which is reported to have high influence on the yield (Nalini, 1981). Minimum temperature in the 21st, 22nd, 24th and 26th weeks (May 21 to June 3, June 11 to 17, June 25 to July 1) showed significant positive correlation.

Minimum temperature in the 11th, 12th and 13th fortnights had substantial positive influence on the yield of this variety.

Tables 28 and 29 present the estimated forecasting models at the first stage from weekly weather parameters. Ninty six per cent of the variation could be accounted by relative humidity in the second group of standard weeks and minimum temperature during this period accounts for 98% of the variation in yield. The prediction of the yield of this variety is possible in the second week of August using minimum temperature alone in the second group of standard weeks with remarkable accuracy.

Among the 10 generated variables and the trend variable, four were included in the second stage model. $Z_{MX.1}$, $Z_{MX.2}$, $Z_{MN.2}$ and $Z_{RH.2}$ were the predictor variables and the corresponding coefficient of determination was .992.

Here also with four generated variables making use of weather elements from the whole of critical period, the increase in predictability was only 4 per cent over the model making use of the minimum temperature of the second half of the critical period. Therefore the first stage model with minimum temperature of the second half of the critical period is perhaps the best forecasting model for this variety.

Table 81 provides the first stage regression models estimated from the weather elements in fortnights of critical period. The model with minimum temperature in various fortnights as explanatory variables had a coefficient of determination of .80. The final model with $Z_{MN}$ and $Z_{RH}$ as predictor variables had a predictability 83.5 per cent.

The predictability of the model using fortnightly data is far below compared to that using weekly weather elements and hence the model using weekly weather elements is to be prefered.

Variety 8 - Kaniyakadan

Relative humidity in the 27th and 28th weeks (July 2 to 15) and number of rainy days in the 16th standard week (April 16 to 22) had substantial negative influence on the yield. This may be because the higher relative humidity during this period may produce ideal conditions for the multiplication of the pathogens and thus adversely affect the yield. Rainfall during June 4 to 10 had significant positive correlation.

Relative humidity in the 14th and 15th fortnights had significant negative correlation with the yield of this variety. No other weather parameters showed substantial effect on the yield.

Tables 30 and 31 present the estimates of the forecasting models at the first stage from weekly weather parameters. It may be noted that maximum temperature during the premonsoon period (April 9 to June 10) alone could account for 94 per cent of the variation in yield and relative humidity in the second group of standard weeks (June 11 to August 12) could accounts for 92 per cent of the variation. The prediction of the yield of this variety is possible as early as in the second week of June, using the maximum temperature alone in various standard weeks in group I.

The predictability for the second stage model using the weekly weather parameters was 99.2 per cent and the explanatory variables in the model were $Z_{MX.1}$, $Z_{MN.1}$, $Z_{RH.1}$, $Z_{RH.2}$, $Z_{RF.1}$, $Z_{NR.2}$ and T. The increase in predictability is only very marginal compared to that using maximum temperature alone of the first half of the critical period, even though the second stage model utilized six generated variables along with the trend. Therefore the first stage prediction model with maximum temperature of the first half of the critical period could be very well used for predicting yield of this variety.

Table 82 provides the estimates of the forecasting models at the first stage using the fortnightly weather parameters. Relative humidity in various fortnights of critical period could explain 85 per cent of the variation in yield. The final model using four generated variables viz. $Z_{MX}$, $Z_{MN}$, $Z_{RH}$ and $Z_{RF}$ had predictability 93.9 per cent.

In fact the first stage model using weekly maximum temperature from April 9 to June 10 has higher predictability than that of the second stage model from the fortnightly weather elements.

Variety 9 - Karivilanchy

For this variety minimum temperature in the 21st and 22nd weeks (May 21 to June 3) showed significant positive correlation with yield. No other weather variable in the standard weeks of critical period had substantial influence on the yield.

From among the fortnightly weather variables, MNT in the 11th fortnight which corresponds to the 21st and 22nd standard weeks had significant positive correlation with the yield.

Estimated first stage models reveal that minimum temperature in the group II (June 11 to August 18) alone could explain 91 per cent of variation in yield and relative humidity in the same period could explain 90 per cent of the variation (Tables 32 and 33).

Table 74 gives estimated second stage forecasting models from weekly weather data. $Z_{MX.1}$, $Z_{MX.2}$, $Z_{MN.1}$, $Z_{MN.2}$, $Z_{RH.2}$, $Z_{NR.1}$ and $Z_{NR.2}$ were the predictor variables that entered in the final model which had coefficient of determination .99.

Here the second stage model had seven generated explanatory variables and had a predictability of 99 per cent where as the first stage model with minimum temperature of the second group of standard weeks as explanatory variables alone has a predictability of 91 per cent. Therefore this first stage forecasting model using minimum temperature of the second half of the critical period could very well be used for forecasting the yield.

Sixty four per cent of the variation in the annual yield of this variety was accounted by number of rainy days in different fortnights of the critical period. Four generated variables viz. $Z_{MX}$, $Z_{MN}$, $Z_{RH}$ and $Z_{NR}$ were included in the final prediction model with a coefficient of determination .81.

The forecasting model using weekly data is found to be superior.

Variety 10 - Karimunda-1

Rainfall in the 20th standard week (May 14 to 20) showed significant positive correlation. This period is the time when the premonsoon showers, which is a tregering factor of flower bud differentiation, are received. Premonsoon showers were reported to have high influence on pepper yield (Menon, 1981). Minimum temperature in the 17th standard week had substantial influence on the yield and the correlation obtained was negative.

The fortnightly weather variables did not show any substantial influence on the yield of this variety.

The ten first stage forecasting models estimated from weekly weather elements are given in Tables 34 and 35. It may be noted that like the variety Kaniyakadan, for this variety also the first stage model with maximum temperature in the premonsoon period (April 9 to June 10) had a predictability 95 per cent. Hence it could be stated that though weather variables of individual weeks did not indicate substantial influence on yield, the same variable when considered for longer period has remarkable influence on yield.

The final model came out with $Z_{MX.1}$, $Z_{MN.1}$, $Z_{RF.2}$ and T as the predictor variables with a coefficient of determination of 0.994.

Of the first stage models using fortnightly weather data, the one using relative humidity had maximum $R^2$ value of .74. Four generated variables viz. $Z_{MX}$, $Z_{MN}$, $Z_{RH}$ and $Z_{NR}$ were included in the final forecasting model which had coefficient of determination .912.

Here also the model using weekly weather elements was found to have higher predictability.

Variety 11 - Karimunda-2

RH in the 26th week (June 25 to August 1) showed significant negative correlation for this variety while minimum temperature in the 21st, 22nd, 23rd and 25th weeks showed significant positive correlation with yield. The negative correlation of relative humidity in the 26th week may perhaps be due to the adverse effect of diseases on the crop.

For the fortnightly weather data, minimum temperature in the 11th and 13th fortnights showed substantial positive influence on the yield. No other weather variable in various fortnights of critical period showed any substantial effect on the crop.

The estimated first stage prediction models from the weekly weather parameters are given in Tables 36 and 37. It is worth noting that RH during the period from April 15 to June 10, could explain 70 per cent of variation in the annual yield of this variety and 84 per cent of the variation could be accounted by minimum temperature during the same period.

Among the ten generated variables and the T (trend) seven were selected as predictor variables in the final model and the predictability of the model was 97.8 per cent. This model can predict the yield of this variety more accurately.

Table 84 provides estimates of the first stage model from the fortnightly weather data. Relative humidity in various fortnights of the critical period could explain 82 per cent of the variation in the annual yield. Four generated variables viz. $Z_{MX}$, $Z_{MN}$, $Z_{RH}$ and

$Z_{NR}$ were included in the final model with a coefficient of determination of .947.

Variety 12 - Karimunda-3

The maximum temperature in most of the standard weeks of the critical period showed significant positive correlation in the case of this variety. Relative humidity in the 23rd week (June 4 to 10) had significant negative correlation. Relative humidity during June 11 to August 12 had adverse effect on the yield of other varieties also.

Maximum temperature in the 8th, 11th, 12th and 13th fortnights had significant positive correlation while relative humidity in the 12th fortnight had significant negative correlation.

Tables 38 and 39 provide estimated first stage models from weekly weather parameters of the critical period. Maximum temperature in various standard weeks during April 9 to June 10 alone could explain 76 per cent of the variation in yield and 75 per cent of the variation was accounted by relative humidity during June 11 to August 12.

Among the 10 generated variables and the trend variable, five variables were included in the final model, and they were $Z_{MX.1}$, $Z_{RH.1}$, $Z_{RH.2}$, $Z_{RF.1}$ and $Z_{RF.2}$ with a coefficient of determination of .968.

Table 86 reveals that relative humidity in various fortnights of the critical period alone could account for 86 per cent of the variation in the annual yield. Only two generated variables viz. $Z_{MX}$ and $Z_{RF}$ were selected as predictor variables in the final forecasting model with a predictability of 85.4 per cent.

For practical purposes the second stage model from weekly weather data, which has very high predictability, can be recommended for predicting yield of this variety.

Variety 13 - Karivally

Maximum temperature in the 18th, 19th and 30th weeks (April 30 to May 20) and minimum temperature in the 21st, 22nd and 26th weeks (May 21 to June 3, June 25 to July 1) showed significant positive correlation with the yield of this variety. Other weather parameters in any of the standard weeks of critical period did not have substantial influence on yield.

When fortnightly weather elements were considered, maximum temperature in the 10th fortnight, minimum temperature in the 11th fortnight and rainfall in the 12th fortnight showed significant positive correlation while relative humidity in the 15th fortnight showed significant negative correlation.

The ten first stage forecasting models estimated from weekly weather elements are given in Tables 40 and 41. It may be noted that relative humidity in various standard weeks during June 11 to August 12 alone could explain 97% of the variation in the annual yield of this variety and minimum temperature in various standard weeks during the same period could explain 84% of the variation. Hence it could be stated that though the weather elements of individuals weeks did not indicate substantial influence on the yield, the same variable when considered for a longer period has remarkable influence on the yield. The model from relative humidity itself could very well be used to forecast the yield with a very low error in prediction. Moreover yield prediction can be done as early as in the second week of August, if this first stage model is used.

The final prediction model include three generated variables and the trend value as the predictorn variables. $Z_{MX.2}$, $Z_{RH.2}$, $Z_{NR.2}$ and T could account for 99 per cent of the variation in the yield. With a negligible error, the prediction of the yield of this variety can be done using this final model.

Table 87 presents estimated forecasting models at the first stage from fortnightly weather parameters. Minimum temperature in various fortnights of critical period could explain 79 per cent of the variation in the annual yield. The final model with $Z_{MX}$ and $Z_{MN}$ as the predictor variables had a coefficient of determination of 0.861.

Here also the model using weather elements in standard weeks was found to have higher predictability. Moreover the first stage model with relative humidity during June 11 to August 12 can be used to predict annual yield at the second week of August.

Variety 14 - Kottanadan

Minimum temperature in the 16th week (April 16 to 22) and number of rainy days in the 27th standard week (july 2 to 8) had significant negative correlation with the yield of this variety.

Minimum temperature in the 8th fortnight which corresponds to the 16th standard week, had significant negative correlation.

The estimated first stage regression models from weekly weather parameters are given in Tables 42 and 43. Minimum temperature in various standard weeks during April 9 to June 10 alone could explain 86 per cent of variation in the yield and number of rainy days during the same period could explain 85 per cent of the variation.

Among the 10 generated variables and trend variable T, five were selected as predictor variables in the second stage model. The predictability of this model was 98.8 per cent.

Sixty six per cent of the variation in yield of this variety, could be explained by minimum temperature in the fortnights of the critical period. The second stage model for this variety included three predictor variables. They are $Z_{MX}$, $Z_{MN}$ and $Z_{RH}$. The predictability for the final model was 87.6 per cent.

Variety 15 - Kumbhakody

On examining Tables 1 to 10, it may be noted that relative humidity in the 27th and 28th weeks (July 2 to 15) had significant negative correlation with the yield of this variety. This may be due to the adverse effect of pathogens on the crop. No other variable was found to influence yield of this variety when considered individually. Even when variables of fortnights were considered relative humidity during the 14th fortnight alone was found to have significant negative correlation with yield of this variety. In fact the 14th fortnight coincides with 27th and 28th standard weeks for which the relative humidity was found to influence the yield.

The estimated first stage regression models from weekly weather parameters are given in Tables 44 and 45. Ninty per cent of the variability in yield of this variety could be accounted by maximum temperature in various standard weeks during April 9 to June 10. If we use this model for predicting the yield, the prediction is possible as early as in the second week of June.

Five generated variables along with trend variable were selected as predictor variables for the second stage model. The explanatory variables that entered in the final model were $Z_{MX.1}$, $Z_{MN.1}$, $Z_{MN.2}$, $Z_{RH.1}$, $Z_{NR.2}$ and T with the coefficient of determination of .968. The details of the model can be had from Table 74.

Table 89 provides the estimated first stage regression models from fortnightly weather parameters. We could note that 95 per cent of the variation in yield could be accounted by relative humidity in various fortnights of critical period. $Z_{RH}$ alone was included in the final model which had a coefficient of determination of .95.

Variety 16 - Kuthiravally

Tables 1 to 10 reveal that minimum temperature in the 23rd and 24th weeks (June 4 to 17), rainfall in the 20th and 26th weeks and number of rainy days in the 19th and 20th weeks had significant positive correlation with the yield of this variety. In short premonsoon showers have a major role for determining yield of this variety. No other weather element of standard weeks had significant correlation with yield. None of the variables showed negative significant correlation in the case of this variety.

When weather elements of fortnights were considered (Table 11 to 15) maximum temperature and minimum temperature during 12th fortnight and rainfall during 10th fortnight had positive significant correlation with yield of Kuthiravally.

The estimated first stage regression models from weekly weather parameters are presented in Tables 46 and 47. Eighty six per cent of the variation in yield could be explained by minimum temperature in the first group of standard weeks (April 9 to June 10). The percentage of variation explained by rainfall in the second group (June 11 to August 15) was also 86.

Six generated variables were selected as predictor variables in the final forecasting model. They were $Z_{MX.1}$, $Z_{MN.1}$, $Z_{MN.2}$, $Z_{RH.1}$, $Z_{RF.2}$ and $Z_{NR.2}$. The $R^2$ value for this model was .992.

The estimated first stage regression models from the fortnightly weather parameters are given in Table 90. The largest $R^2$ was observed for the model from minimum temperature ($R^2$ = .88). The second stage forecasting model in Table 104 included two generated variables viz. $Z_{MN}$ and $Z_{RH}$ as predictor variables and 95.3 per cent of the variation in the yield could be explained by it.

Variety 17 - Kuthiravally - AR

Tables 1 to 10 reveal that minimum temperature in the 24th and 25th weeks (June 11 to 24) had significant positive correlation with yield while relative humidity in the 14th, 16th and 19th weeks and number of rainy days in the 24th and 29th weeks had substantial negative correlation with the yield of this variety.

For the fortnightly data, even a single variable in the fortnights of critical period did not show substantial influence on the yield.

The estimated first stage regression models from weekly data are provided in Tables 48 to 49. Maximum $R^2$ value was observed for the model with relative humidity in the second group of standard weeks (June 11 to August 12) as explanatory variables, the value being .87. The model from relative humidity in the first group of standard weeks (April 9 to June 10) had a $R^2$ value of .83.

The estimated second stage model presented in Table 74, had 5 predictor variables viz. $Z_{MX.1}$, $Z_{MN.1}$, $Z_{RH.1}$, $Z_{RH.2}$ and $Z_{RF.2}$. This final model could explain 98.6 per cent of the variation in the yield of this variety.

Eighty per cent of the variation in yield could explained by relative humidity in the fortnights (Table 91). The estimated second stage forecasting model is given in Table 104. There were three predictor variables in the second stage model. They were $Z_{MX}$, $Z_{RH}$ and $Z_{NR}$. The predictability for this model was 93.5 per cent.

Variety 18 - Munda

Tables 1 to 10 reveal that maximum temperature in the 22nd and 23rd weeks (May 28 - June 10) had significant positive correlation while relative humidity in the 21st, 22nd and 23rd weeks (May 21 - June 10) and rainfall in 22nd week had significant negative correlation with yield of this variety. Rainfall in the 22nd week had negative correlation which could be because of the need for a dry spell after the flower bud initiation (KAU, 1954).

Maximum temperature in the 11th and 12th fortnights had significant positive correlation while relative humidity in the 12th fortnight and rainfall in the 11th fortnight had significant negative correlation with yield.

Estimated first stage regression models from the weekly weather parameters are presented in Tables 50 and 51. Relative humidity in the standard weeks belonging to April 9 to June 10 alone could explain 91 per cent of variation in the yield. Number of rainy days in the same period could explain 86 per cent of the variation.

The estimated second stage regression model included six predictor variables. They were $Z_{MX.1}$, $Z_{MN.1}$, $Z_{RF.2}$, $Z_{NR.1}$ and T. The $R^2$ value for this model was .978.

The first stage model with relative humidity of the standard weeks in the first half of the critical period can very well be used for predicting yield of this variety as the predictability is as high as 91 per cent.

The estimated first stage regression models from the fortnightly data are given in Table 92. The model from maximum temperature alone had $R^2$ value of .84. The second stage model included four predictor variables and they were $Z_{MX}$, $Z_{RH}$, $Z_{RF}$ and $Z_{NR}$. The $R^2$ value for this model was .895 which was even lower than the first stage model with relative humidity of standard weeks in the first half of the critical period.

Variety 19 - Narayakodi

Relative humidity and number of rainy days in the 28th week (July 9 to 15) had significant negative correlation with yield of this variety (Tables 1 to 10). No other weather variable of standard weeks was having significant correlation with yield when considered individually. Negative correlation of relative humidity as well as number of rainy days with yield was observed for the standard weeks for which the monsoon was in peek. It could be because of the adverse effect of excessive rains on the infloresence or due to the indirect effect of rains through pathogens and diseases.

For the fortnightly data relative humidity in the 14th fortnight and number of rainy days in the 16th fortnight had significant negative correlation with the yield of this variety.

The estimated first stage regression models from weekly weather data are given in Tables 52 and 53. It was observed that 90 per cent of the variation in yield could be accounted by relative humidity in the second group of standard weeks (June 10 to August 12), 84 per cent of the variation could be explained by maximum temperature in the first group of standard weeks and an equal amount by rainfall in the second group of standard weeks.

The estimated second stage model is given in Table 74. Four predictor variables viz. $Z_{MN.2}$, $Z_{RH.2}$, $Z_{RF.2}$ and $Z_{NR.1}$ were selected in this final forecasting model which had $R^2$ value of .988.

Table 93 gives the estimated first stage models from fortnightly weather parameters. Eighty six per cent of the total variation in yield could be accounted by relative humidity in fortnights of the critical period. The estimated second stage model is provided in Table 104 and had $R^2$ value of .904. Three generated variables viz. $Z_{MX}$, $Z_{MN}$ and $Z_{RH}$ were selected into this second stage model.

Here also the model from relative humidity in various standard weeks during June 11 to August 12 can be used as a forecasting model and the yield can be estimated in the second week of August.

Variety 20 - Palulauta

Maximum temperature in the 20th week and number of rainy days in the 17th week showed significant positive correlation with yield of this variety while relative humidity in the 15th and 20th weeks (April 9 to 15, May 14 to 20) had significant negative correlation. Since positive correlation was observed for number of rainy days in the 17th week, the distribution of rainfall in the premonsoon period have high influence on the yield of this variety (Menon, 1981).

Among the weather elements of fortnights relative humidity during 10th fortnight had significant negative correlation with yield (Tables 11 to 15). No other variable could express significant correlation with yield when considered individually.

Tables 54 and 55 give the estimated first stage regression models from weekly weather parameters. Number of rainy days in group I (April 9 to June 10) alone could explain ninty per cent of the total variation in the yield. The prediction of the yield of this variety is possible as early in the second week of June, if we use this model.

The estimated second stage regression model had $R^2$ value of .986. The predictor variables that entered into the final forecasting model were $Z_{MX.1}$, $Z_{MN.1}$, $Z_{RF.2}$, $Z_{NR.1}$ and $Z_{NR.2}$.

Table 94 gives the estimated first stage regression models from the fortnightly weather data. Relative humidity alone could explain 99 per cent of the total variation in the yield. The second stage model had $R^2$ value .992. $Z_{RH}$ and $Z_{RF}$ were selected as predictor variables. The first stage model using relative humidity of fortnights as predictor variables itself has very high predictability and hence can be used as forecasting model for yield of this variety.

Variety 21 - Perumkodi

Relative humidity in the 16th and 18th weeks and rainfall in the 32nd week showed significant negative correlation with yield of this variety while number of rainy days in the 20th week showed significant positive correlation.

Among the weather variables of various fortnights, relative humidity in the 9th fortnight showed significant negative correlation and rainfall in the 10th fortnight showed significant positive correlation with yield of the variety.

Tables 56 and 57 give the estimated first stage regression models from weekly weather parameters. Rainfall in the second group of standard weeks during June 11 to August 12 alone could explain 84 per cent of the variation in yield and relative humidity during April 9 to June 10 could explain 83 per cent of the variation in yield.

The second stage model included four predictor variables viz. $Z_{RH.1}$, $Z_{RH.2}$, $Z_{RF.1}$ and $Z_{RF.2}$ and T could account for 95.65 per cent of the variation in yield.

The estimated first stage models from the fortnightly data are given in Table 95. The first stage model with relative humidity in fortnights of critical period as explanatory variables had the highest $R^2$ value of .88. The second stage model given in Table 104 had $R^2$ value of .935. Three predictor variables viz. $Z_{MX}$, $Z_{MN}$ and $Z_{RH}$ were included in this model.

Variety 22 - Perumunda

Minimum temperature in the 27th week and number of rainy days in the 28th week had significant negative correlation with yield of this variety.

For the fortnightly weather data the minimum temperature in the 13th and 14th fortnights and number of rainy days in the 16th fortnight showed significant negative correlation with yield of this variety.

The estimated first stage regression models using weekly weather elements are presented in Tables 58 and 59. Ninety two per cent of the variation in yield could be explained by the model with relative humidity in the second group of standard weeks as explanatory variables.

$Z_{MN.2}$, $Z_{RH.1}$, $Z_{RH.2}$ and $Z_{RF.2}$ were selected as predictor variables in the second stage prediction model by step-wise regression. The $R^2$ for this forecasting model was as high as .984 (Table 74).

It may be noted, from the estimated first stage models from fortnightly data given in Table 96, that 86 per cent of variation in yield could be explained by relative humidity alone from fortnights in the critical period. Four variables generated by the first stage regression viz. $Z_{MX}$, $Z_{MN}$, $Z_{RH}$ and $Z_{RF}$ entered into the final regression model when the step-wise regression was done and this model has $R^2$ value of .972.

Variety 23 - Sullia

Tables 1 to 10 provide coefficients of correlation between weekly weather parameters and yield of different varieties. Maximum temperature and minimum temperature in the 29th week and number of rainy days in the 21st week had significant positive correlation with yield of the variety and rainfall in the 18th week (April 30 to May 6) had significant negative correlation.

Rainfall in the 9th fortnight had negative significant correlation with yield while number of rainy days in the 11th fortnight had significant positive correlation, when the variables were considered for fortnights (Tables 11 to 15).

Tables 60 and 61 give the estimated first stage regression models from weekly weather parameters. Number of rainy days in the first group of standard weeks could explain 86 per cent of the variation in yield of this variety. MNT in the second group of standard weeks also could explain same amount of variation in yield.

The estimated second stage model included for predictor variables viz., $Z_{RH.1}$, $Z_{RH.2}$, $Z_{NR.1}$ and $Z_{NR.2}$ and could attain a predictability of 97.8 per cent.

Table 97 provides the first stage regression models estimated from fortnightly weather data. Seventy six per cent of the variation in yield could be explained by number of rainy days alone in fortnights. $Z_{MN}$, $Z_{RH}$, $Z_{RF}$ and $Z_{NR}$ were the generated variables that entered in the final forecasting model during the process of step-wise regression and this model had $R^2$ value of 89.87 per cent.

Variety 24 - Taliparamba I

Relative humidity in the 24th and 28th week (June 11 to 17, July 9 to 15) had significant negative correlation with the yield of this variety. No other weather variable showed significant correlation.

For the fortnightly data relative humidity in the 14th and 16th fortnights showed significant negative correlation.

Estimated first stage regression models from the weekly weather data are presented in Tables 62 and 63. It may be noted that rainfall in the first group of standard weeks (April 9 to June 10) alone could explain 94 per cent of the total variation in yield, while relative humidity in the group II could account for 91 per cent of the variation. Prediction of the yield of this variety can be done using the model using relative humidity in the group I of standard weeks, with negligible error and the prediction is possible as early as in the second week of June.

$Z_{MN.2}$, $Z_{RH.2}$, $Z_{RF.1}$, $Z_{RF.2}$, $Z_{NR.1}$ and $Z_{NR.2}$ were selected as predictor variables at the second stage by step-wise regression. 99.8 per cent of the variation could be accounted by this forecasting model.

Table 98 provides first stage estimated forecasting models from fortnightly data. Ninty per cent of the total variation in yield could be accounted by relative humidity alone while number of rainy days could explain ninety three per cent of the variation in yield. The second stage prediction model estimated using step-wise regression included only one generated variable viz., $Z_{RH}$. This model had $R^2$ value of 90.

Variety 25 - Taliparamba II

Minimum temperature in the 15th and 16th weeks (April 9 to 22) had significant negative correlation with annual yield of this variety while rainfall in the 24th week and number of rainy days in the 29th week (July 16 to 22) had significant positive correlation.

When weather data for fortnights were considered, minimum temperature in the 8th fortnight had significant negative correlation with yield and rainfall in the 15th fortnight had significant positive correlation (Table 11 to 15).

Tables 64 to 65 provide the first stage regression models estimated from weekly weather data. Ninty five per cent of variation in yield could be explained by minimum temperature in the first group of standard weeks. The prediction can be made with this first stage model with negligible error and as early as in the second week of June.

Four predictor variables were included in the second stage forecasting model. They were $Z_{MX.2}$, $Z_{MN.1}$, $Z_{RH.2}$ and T and accounted for 98.4 per cent of the total variation in yield.

The estimated first stage models from the fortnightly weather parameters are given in Table 99. Minimum temperature alone could explain 79 per cent of the variation. The predictor variables were included in the second stage forecasting model, when step-wise regression was employed. They were $Z_{MN}$ and $Z_{NR}$ and they together could explain 85.93 per cent of the variation in yield (Table 104).

Variety 26 - Taliparamba III

Rainfall in the 32nd week and number of rainy days in the 28th and 32nd week showed significant negative correlation with yield. The weather parameters in the premonsoon period did not show any significant correlation.

Number of rainy days in the 14th and 16th fortnights had significant negative correlation with the yield of this variety (Table 11 to 15).

The estimated first stage models in Tables 66 and 67 reveal that the model using rainfall in the standard weeks during June 11 to August 12, had highest $R^2$ value of .93 among the first stage models. Maximum temperature in the second group of standard weeks accounts for ninty per cent of the variation.

The estimated second stage model from weekly weather parameters is given in Table 74. $Z_{MX.2}$, $Z_{MN.1}$, $Z_{RH.2}$ and $Z_{RF.2}$ were the variables entered in this model and it could explain 99.6 per cent of the variation in yield of this variety.

Table 100 provides the first stage models estimated from fortnightly weather data. Number of rainy days alone could explain ninty three per cent of the variation in yield and the model using relative humidity in various fortnights had $R^2$ value of .91. The second stage forecasting model for this variety included three predictor variables viz. $Z_{RH}$, $Z_{RF}$ and $Z_{NR}$ and could explain 97.8 per cent of the variation in the yield of this variety.

Variety 27 - Taliparamba IV

Maximum temperature in the 29th week and minimum temperature in the 29th and 32nd weeks had substantial positive influence on the yield while minimum temperature in the 27th week had negative influence on the yield.

Minimum temperature in the 14th fortnight had significant negative correlation with the yield of this variety. No other variable when considered with reference to the fortnights had significant influence on yield in this case.

The estimated first stage regression models from weekly weather parameters are given in Tables 68 and 69. The model using minimum temperature in standard weeks of group II had greatest $R^2$ value ($R^2$ = .77).

Six generated variables were selected as predictor variables in the second stage forecasting model and the details are given Table 74. $Z_{MX.1}$, $Z_{MX.2}$, $Z_{MN.2}$, $Z_{RH.1}$, $Z_{RH.2}$ and $Z_{NR.1}$ were the predictor variables entered in to the final forecasting model and could explain 96.82 per cent of the variation in yield of this variety.

The first stage models estimated from fortnightly weather variables are given in Table 101. Only 65 per cent of the variation could be explained by relative humidity in fortnights of critical period. The second stage model given in Table 104 had $R^2$ value of .828 and the variables entered into this model when step-wise regression was done were $Z_{MX}$, $Z_{MN}$, $Z_{RH}$ and $Z_{NR}$.

Variety 28 - Valli

Table 1 to 10 reveal that number of rainy days in the 17th week was the only weather variable which showed significant positive correlation with yield of this variety. In other words premonsoon showers during this standard week had positive influence on the yield and no other variable when considered for each standard week seperately, could express substantial influence on the yield of this variety.

When weather variables were considered with reference to fortnightly periods, MXT in the 10th fortnight alone could influence the yield significantly and that too positively (Tables 11 to 15).

From the estimated first stage regression models given in Tables 70 and 71, we could note that nearly eighty per cent of the total variation in yield could be explained by MNT in thestandard weeks during June 11th to August 12.

The $R^2$ value for the second stage forecasting model was .98 and the predictor variables entered in this model were $Z_{MN.1}$, $Z_{MN.2}$, $Z_{RH.1}$, $Z_{RH.2}$ and $Z_{NR.2}$ as a result of step-wise regression.

The first stage model using maximum temperature in fortnights of critical period had $R^2$ value of .70. From Table 104 we could get the second stage forecasting model from the fortnightly data. 86.86 per cent of the variation could be accounted by this forecasting model in which the prediction variables selected were $Z_{MX}$, $Z_{MN}$, $Z_{RF}$ and $Z_{NR}$.

Variety 29 - Valiyakodi

Maximum temperature in the 26th week (June 26 to 1) showed substantial negative influence on the yield while rainfall in the 20th week and number of rainy days in the 19th and 20th weeks had substantial positive influence on the yield.

When the fortnightly data were considered, rainfall and number of rainy days in the 10th fortnight had significant positive correlation. No other variable in a fortnight could express substantial influence on yield.

The estimated first stage models in Tables 72 and 73 reveal that 92 per cent of the variation could be accounted by relative humidity in the first group of standard weeks and ninty one per cent of the variation could be explained by minimum temperature in the same period.

The estimated second stage forecasting model given in Table 74 had $R^2$ value of .986 and predictor variables selected for this model were $Z_{MN.1}$, $Z_{RH.1}$, $Z_{RF.2}$ and $Z_{NR.1}$.

Table 103 reveal that number of rainy days in the fortnights could account for 85 per cent of the variation in yield of this variety. The second stage forecasting model given in Table 104 had $R^2$ value of .964. All the five generated variables were selected as predictor variables in this forecasting model when step-wise regression was employed.

On the whole, the influence of the different weather elements considered viz. maximum temperature, minimum temperature, relative humidity, rainfall and number of rainy days was not uniform on the performance of different varieties. In other words different varieties of pepper are affected by weather elements differently.

Perhaps the most important reason for such differencing response of different varieties to weather changes could be the existance of interaction on genotypes with environments. Though all the varieties for which data were utilized had been grown in the same research station, there is likely to be variability in soil type and micro environments for the different varieties. Their contribution on the performance of the crop cannot be under estimated. Another possible reason for the differing type of influence of weather elements could be biennial bearing tendency which is a general characteristic of perennial crops.

Even though the pattern of influence of weather elements differs from variety to variety, the yield forecasting models estimated for all varieties have very high predictability especially those utilizing the weekly data. In other wards these forecasting models can be used to predict the yield of all the 29 varieties considered well ahead of the harvest with remarkable accuracy. The predictability of 'almost' all forecasting models using weekly weather data is in the neighbourhood of ninty nine per cent. In most of the cases the prediction can be done as early as in the second week of June even with the first stage models with high accuracy.

Though the predictability of forecasting models utilizing weekly weather data had been very close to unity in all cases the influence of any weather element during any particular standard week was not that high. In other wards, only the cumulative effects of weather factors on the yield of different varieties was substantial.

When the weather data with reference to the fortnights were considered, the forecasting models in general had less predictability compared to those utilizing weekly data. Still the final forecasting models utilizing fortnightly weather data can also be made use of for prediction of yield with satisfactory predictability.

# Tables

Table 1. Coefficient of correlation between the weekly maximum temperature and the yield of pepper

| Varieties | Standard weeks 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .286 | .216 | .161 | .342 | .478 | .343 | .430 | .317 | .017 |
| 2 | .201 | .242 | .340 | .361 | .450 | .644 | .272 | .072 | -.367 |
| 3 | .116 | .065 | .296 | .343 | .433 | .461 | .348 | .388 | .085 |
| 4 | .517* | .115 | -.420 | -.050 | .019 | .019 | .507 | .549* | .580* |
| 5 | .135 | .105 | .172 | .334 | .280 | .303 | .001 | -.061 | -.280 |
| 6 | .083 | .068 | .232 | .364 | .292 | .319 | -.081 | -.131 | -.345 |
| 7 | .208 | .104 | -.061 | .173 | .090 | .064 | .045 | .038 | -.039 |
| 8 | .119 | .177 | .282 | .50 | .384 | .244 | -.043 | .145 | -.373 |
| 9 | .003 | -.016 | .128 | .213 | .135 | .229 | -.049 | -.108 | -.179 |
| 10 | .419 | .139 | .199 | .251 | .411 | -.081 | .159 | .454 | .471 |
| 11 | .288 | .427 | .183 | .321 | .351 | .087 | .033 | .298 | .108 |
| 12 | .695** | .448 | .029 | .518* | .564* | .153 | .682** | .711** | .598* |
| 13 | .366 | .499 | .318 | .568* | .637* | .560* | .334 | .324 | -.127 |
| 14 | .226 | .137 | .214 | .286 | .121 | .380 | .204 | .097 | -.053 |
| 15 | .078 | -.004 | .238 | .195 | .172 | .426 | .119 | .374 | -.234 |
| 16 | .385 | -.007 | -.372 | .112 | .020 | -.348 | -.016 | .333 | .495 |
| 17 | .245 | .131 | -.024 | .512 | .405 | .093 | .483 | .386 | .322 |
| 18 | .350 | .098 | -.186 | .151 | .215 | -.081 | .233 | .653** | .673** |
| 19 | .193 | .062 | -.028 | .373 | .258 | .127 | -.038 | .034 | -.188 |
| 20 | .286 | .070 | .214 | .033 | .308 | .520* | .382 | .324 | .169 |
| 21 | .321 | .194 | -.253 | .465 | .356 | -.200 | .088 | .252 | .205 |
| 22 | -.169 | -.371 | -.098 | -.067 | -.082 | -.035 | -.242 | -.078 | -.114 |
| 23 | -.233 | -.282 | -.039 | .212 | -.002 | .053 | -.269 | -.163 | -.218 |
| 24 | .237 | .179 | .203 | .461 | .469 | .373 | .283 | .445 | -.054 |
| 25 | .166 | .002 | .102 | -.145 | .238 | .256 | -.015 | .065 | .205 |
| 26 | .097 | -.027 | -.094 | .322 | .164 | .026 | -.138 | -.133 | -.166 |
| 27 | -.213 | -.259 | -.131 | .049 | -.109 | -.057 | -.258 | .094 | .073 |
| 28 | .355 | .234 | .202 | .256 | .428 | .532* | .412 | .266 | -.113 |
| 29 | .024 | -.172 | -.434 | -.061 | -.212 | -.499 | -.264 | -.038 | .343 |

* Significant at 5% level
** Significant at 1% level

Table 2. Coefficients of correlation between the weekly maximum temperature and the yield of pepper

| Vari- | Standard weeks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| eties | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| 1 | .035 | .05 | .040 | .148 | .293 | .070 | .259 | -.119 | -.122 |
| 2 | -.165 | .253 | .296 | .099 | .191 | .329 | .119 | -.308 | .068 |
| 3 | .029 | .294 | .20 | -.211 | .298 | .434 | .061 | .102 | .287 |
| 4 | .440 | .260 | .117 | .106 | .232 | -.197 | .220 | .023 | .176 |
| 5 | .022 | .030 | -.016 | .307 | .066 | .237 | .213 | -.332 | .055 |
| 6 | -.077 | -.130 | -.157 | .325 | .383 | .124 | .077 | -.015 | .044 |
| 7 | .189 | .126 | .018 | .265 | -.234 | .143 | .154 | -.542* | -.019 |
| 8 | .114 | .114 | -.071 | .069 | .469 | .434 | -.26 | .079 | .110 |
| 9 | -.003 | .066 | .021 | .176 | -.228 | .309 | .214 | -.478 | .075 |
| 10 | .330 | .146 | -.077 | .058 | .226 | -.220 | .023 | .074 | .252 |
| 11 | .023 | .105 | .020 | .130 | -.296 | -.014 | -.201 | -.142 | -.034 |
| 12 | .615** | .602* | .367 | .300 | .176 | -.044 | .088 | -.300 | .301 |
| 13 | -.136 | .122 | .121 | .271 | -.075 | .150 | .011 | -.440 | -.143 |
| 14 | -.052 | .269 | .229 | .265 | .065 | .106 | .101 | -.170 | .040 |
| 15 | -.099 | .042 | .044 | -.046 | .421 | .349 | -.002 | .057 | .062 |
| 16 | .486 | .035 | -.338 | .073 | -.101 | -.156 | .195 | -.076 | .203 |
| 17 | .518* | .569* | .296 | -.097 | .380 | .313 | .080 | .109 | .490 |
| 18 | .343 | .049 | -.213 | -.099 | .001 | .002 | .143 | .295 | .214 |
| 19 | .185 | -.093 | -.266 | .269 | .302 | .200 | .219 | -.029 | .080 |
| 20 | -.196 | .102 | .170 | -.125 | .278 | -.107 | .271 | .032 | .185 |
| 21 | .407 | -.108 | -.380 | .250 | .220 | -.119 | .260 | .112 | .096 |
| 22 | .142 | -.169 | -.359 | -.119 | .496 | .304 | .117 | .392 | .311 |
| 23 | .041 | -.145 | -.356 | -.117 | .020 | .585* | .227 | .102 | .148 |
| 24 | .182 | .426 | .193 | -.258 | .443 | .463 | -.200 | .059 | .373 |
| 25 | -.337 | -.144 | -.089 | -.114 | -.176 | -.309 | .183 | .013 | .089 |
| 26 | .122 | -.215 | -.364 | .311 | .270 | .016 | .219 | -.038 | .074 |
| 27 | .081 | -.174 | -.456 | -.358 | .048 | .556* | .079 | .376 | .187 |
| 28 | -.066 | .081 | .135 | .243 | .285 | .074 | .265 | -.275 | -.112 |
| 29 | .274 | -.256 | -.531* | .005 | -.47 | -.002 | .346 | .045 | -.076 |

* Significant at 5% level
** Significant at 1% level

Table 3. Coefficients of correlation between the weekly minimum temperature and the yield of pepper

| Vari- eties | Standard weeks 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .009 | .187 | -.418 | .233 | .370 | -.034 | .108 | .208 | -.144 |
| 2 | -.436 | -.076 | -.307 | .244 | -.116 | .252 | .335 | .424 | -.068 |
| 3 | -.226 | .086 | -.387 | .078 | .173 | -.208 | -.205 | .010 | -.077 |
| 4 | .437 | .062 | .00 | -.297 | -.149 | -.040 | -.036 | .182 | .289 |
| 5 | -.339 | -.177 | -.204 | .244 | -.124 | .187 | .521* | .576* | .096 |
| 6 | -.504 | -.340 | -.343 | .191 | -.046 | .167 | .124 | .144 | -.231 |
| 7 | .127 | .094 | .017 | .126 | -.152 | .063 | .722** | .818** | .450 |
| 8 | -.430 | .079 | -.422 | .0801 | -.015 | -.345 | .002 | .155 | -.225 |
| 9 | -.108 | -.039 | -.034 | .238 | -.093 | .166 | .644** | .689** | .303 |
| 10 | -.386 | -.315 | -.593* | -.098 | .077 | -.331 | -.178 | .044 | .322 |
| 11 | -.452 | -.160 | .079 | .063 | -.371 | .079 | .641** | .557* | .534* |
| 12 | .073 | .086 | -.073 | .201 | .166 | -.225 | .278 | .511 | .656** |
| 13 | -.345 | .060 | -.099 | .356 | -.065 | .299 | .771** | .795** | .322 |
| 14 | -.503 | -.586* | -.218 | .065 | -.458 | .241 | .186 | .320 | .018 |
| 15 | -.28 | .002 | -.436 | -.129 | -.251 | -.020 | -.073 | .192 | -.369 |
| 16 | -.136 | -.304 | -.213 | -.324 | -.332 | -.220 | .216 | .440 | .539* |
| 17 | -.132 | .089 | -.052 | .207 | .386 | -.446 | -.401 | -.197 | .081 |
| 18 | -.053 | -.109 | -.179 | -.30 | -.175 | -.264 | .014 | .198 | .406 |
| 19 | -.377 | -.219 | -.342 | .064 | -.118 | -.031 | .219 | .350 | -.079 |
| 20 | -.387 | -.324 | -.511 | -.112 | -.089 | .298 | -.193 | -.043 | -.066 |
| 21 | -.393 | -.221 | -.097 | .098 | .083 | -.112 | .078 | .149 | .114 |
| 22 | -.201 | -.173 | -.382 | -.203 | .026 | -.285 | -.503 | -.333 | -.428 |
| 23 | -.230 | -.083 | -.279 | -.014 | -.054 | -.232 | .059 | .198 | -.156 |
| 24 | -.378 | .167 | -.376 | -.035 | .011 | -.365 | -.198 | .054 | -.047 |
| 25 | -.586* | -.672** | -.305 | -.266 | -.481 | .488 | .126 | .094 | .233 |
| 26 | -.364 | -.317 | -.202 | .112 | -.014 | .099 | .139 | .182 | -.093 |
| 27 | -.035 | .025 | -.369 | -.338 | -.119 | -.463 | -.209 | .017 | -.122 |
| 28 | -.041 | .064 | -.442 | .159 | .069 | .203 | .260 | .449 | -.080 |
| 29 | .036 | -.234 | -.069 | -.240 | -.240 | -.224 | .299 | .382 | .387 |

* Significant at 5% level
** Significant at 1% level

Table 4. Coefficients of correlation between the weekly minimum temperature and the yield of pepper

| Vari- | Standard weeks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| eties | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| 1 | -.264 | -.110 | -.058 | -.101 | -.060 | .025 | .212 | -.30 | -.120 |
| 2 | -.073 | .224 | .263 | .066 | .106 | .145 | .080 | -.208 | -.169 |
| 3 | -.321 | -.178 | -.278 | -.45 | -.456 | .303 | .004 | -.109 | .121 |
| 4 | .333 | .022 | -.064 | .011 | .335 | -.104 | .188 | .084 | -.157 |
| 5 | .201 | .091 | .375 | .229 | .265 | .174 | .185 | -.043 | -.080 |
| 6 | -.116 | -.097 | .003 | -.008 | .015 | -.045 | .055 | -.201 | -.072 |
| 7 | .572* | .170 | .616* | .444 | .479 | .303 | .134 | .132 | -.097 |
| 8 | -.067 | .139 | -.070 | -.206 | -.001 | .163 | -.313 | -.202 | .029 |
| 9 | .315 | -.013 | .505 | .274 | .168 | .418 | .194 | .138 | .034 |
| 10 | .060 | -.133 | -.34 | -.283 | -.145 | -.278 | .010 | -.232 | -.140 |
| 11 | .323 | .528* | .505 | .427 | .316 | -.083 | -.196 | .086 | -.205 |
| 12 | .513 | .158 | .217 | .273 | .301 | -.066 | .052 | -.095 | -.392 |
| 13 | .072 | .309 | .595* | .406 | .245 | .101 | -.018 | -.172 | -.289 |
| 14 | .242 | .391 | .200 | .087 | -.101 | .016 | .090 | -.117 | -.148 |
| 15 | -.291 | .142 | -.174 | -.447 | -.195 | .198 | -.062 | -.142 | .172 |
| 16 | .586* | .039 | -.029 | .066 | .231 | -.078 | .178 | .060 | -.039 |
| 17 | .072 | -.113 | -.392 | -.293 | -.287 | .049 | .034 | -.175 | -.098 |
| 18 | .121 | -.048 | -.189 | -.202 | -.092 | .045 | .105 | .202 | .115 |
| 19 | .130 | .013 | .035 | -.002 | .207 | .046 | .175 | -.085 | -.014 |
| 20 | -.415 | -.166 | -.337 | -.325 | -.263 | -.201 | .249 | -.282 | -.119 |
| 21 | .151 | .019 | -.157 | .064 | .202 | -.344 | .235 | -.175 | -.173 |
| 22 | -.247 | -.474 | -.621* | -.622* | -.373 | .171 | .074 | -.018 | .351 |
| 23 | -.015 | -.266 | -.101 | -.323 | -.297 | .565* | .175 | .174 | .419 |
| 24 | -.127 | .070 | -.296 | -.418 | -.217 | .172 | -.263 | -.258 | -.007 |
| 25 | -.148 | -.050 | -.094 | -.037 | -.159 | -.283 | .205 | -.084 | -.094 |
| 26 | .076 | -.192 | -.056 | .036 | .108 | -.097 | .20 | -.156 | -.056 |
| 27 | -.123 | -.383 | -.372 | -.611* | -.513 | .628* | .019 | .267 | .590* |
| 28 | -.130 | .028 | .179 | .044 | .173 | .064 | .219 | -.234 | -.175 |
| 29 | .483 | -.027 | .127 | .124 | .106 | .207 | .338 | .338 | .228 |

* Significant at 5% level
** Significant at 1% level

Table 5. Coefficient of correlation between the weekly relative humidity and the yield of pepper

| Varieties | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|
| | Standard weeks | | | | | | | | |
| 1 | -.452 | -.552* | -.235 | -.497 | -.339 | -.421 | -.416 | -.55* | -.064 |
| 2 | -.428 | -.177 | -.112 | -.169 | -.329 | -.455 | .016 | -.147 | .197 |
| 3 | -.389 | -.390 | .006 | -.266 | -.313 | -.366 | -.347 | -.491 | -.126 |
| 4 | -.056 | -.166 | -.108 | -.22 | -.09 | -.007 | -.424 | -.517* | -.468 |
| 5 | -.090 | -.041 | -.104 | -.061 | -.013 | -.088 | .208 | .130 | .250 |
| 6 | -.294 | -.297 | -.248 | -.149 | -.078 | -.29 | .174 | .114 | .367 |
| 7 | .306 | .276 | .103 | .145 | .250 | .348 | .255 | .187 | .088 |
| 8 | -.289 | -.268 | -.102 | -.196 | -.134 | -.222 | -.017 | -.176 | .251 |
| 9 | .224 | .228 | .152 | .194 | .209 | .214 | .344 | .299 | .218 |
| 10 | -.257 | -.277 | -.281 | -.367 | -.173 | .030 | -.253 | -.319 | -.257 |
| 11 | -.044 | .144 | -.102 | -.327 | -.285 | .111 | -.243 | -.158 | -.416 |
| 12 | -.172 | -.234 | -.248 | -.353 | -.166 | .040 | -.504 | -.454 | -.587* |
| 13 | -.281 | -.128 | -.104 | -.433 | -.369 | -.240 | -.291 | -.304 | -.210 |
| 14 | -.366 | -.250 | -.472 | -.169 | -.213 | -.271 | .047 | -.029 | .338 |
| 15 | -.397 | -.250 | -.104 | -.347 | -.393 | -.450 | -.304 | -.508 | .243 |
| 16 | .088 | -.019 | -.137 | -.191 | .182 | .344 | .001 | -.165 | -.261 |
| 17 | -.423 | -.527* | -.198 | -.236 | -.099 | -.297 | -.351 | -.391 | -.336 |
| 18 | -.103 | -.277 | -.088 | -.514* | -.246 | .052 | -.607* | -.683** | -.679** |
| 19 | -.251 | -.331 | -.243 | -.273 | -.043 | -.206 | .064 | -.107 | .188 |
| 20 | -.576* | -.339 | -.162 | -.370 | -.498 | -.544* | -.301 | -.477 | -.148 |
| 21 | -.408 | -.528* | -.417 | -.629* | -.166 | -.266 | -.342 | -.382 | -.363 |
| 22 | -.125 | -.314 | .007 | .029 | .165 | -.141 | .173 | -.021 | .329 |
| 23 | .036 | -.199 | .107 | .045 | .219 | .018 | .283 | .051 | .334 |
| 24 | -.443 | -.283 | .026 | -.235 | -.263 | -.337 | -.252 | -.476 | -.112 |
| 25 | -.249 | .031 | -.089 | -.180 | -.278 | -.141 | .034 | -.066 | -.147 |
| 26 | -.177 | -.284 | -.224 | -.157 | .117 | -.137 | .203 | .123 | .225 |
| 27 | .132 | -.193 | .244 | .001 | .197 | .154 | .060 | -.223 | .117 |
| 28 | -.375 | -.337 | -.184 | -.354 | -.339 | -.414 | -.235 | -.406 | .085 |
| 29 | .301 | -.034 | -.054 | -.096 | .305 | .440 | .149 | -.002 | -.121 |

* Significant at 5% level
** Significant at 1% level

Table 6. Coefficients of correlation between the weekly relative humidity and the yield of pepper

| Vari- | Standard weeks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| eties | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| 1 | -.344 | .217 | -.026 | .096 | -.324 | -.015 | .181 | -.105 | -.343 |
| 2 | -.331 | .125 | -.140 | -.315 | -.633* | -.316 | .049 | -.545* | -.429 |
| 3 | -.359 | .071 | -.171 | -.076 | -.386 | -.072 | -.049 | -.095 | -.362 |
| 4 | -.240 | .067 | .005 | .254 | .116 | -.071 | .184 | .289 | .001 |
| 5 | -.155 | .375 | -.005 | -.38 | -.485 | -.313 | .171 | -.463 | -.206 |
| 6 | -.083 | .393 | .128 | -.352 | -.562* | -.031 | .045 | -.642** | -.184 |
| 7 | -.012 | .304 | -.084 | -.273 | -.120 | -.436 | .137 | -.037 | .008 |
| 8 | -.324 | -.154 | -.383 | -.718** | -.805** | -.476 | -.368 | -.636* | -.230 |
| 9 | -.001 | .449 | .031 | -.269 | -.179 | -.288 | .190 | -.133 | -.072 |
| 10 | .045 | .235 | -.145 | -.084 | -.384 | -.008 | -.002 | -.264 | -.348 |
| 11 | -.182 | -.246 | -.515* | -.339 | -.159 | -.317 | .188 | -.158 | -.426 |
| 12 | -.428 | .138 | -.386 | -.016 | -.176 | -.330 | .057 | .109 | -.308 |
| 13 | -.404 | .099 | -.367 | -.293 | -.381 | -.296 | -.022 | -.256 | -.599** |
| 14 | .321 | .466 | .386 | -.095 | -.179 | .105 | .096 | -.223 | -.159 |
| 15 | -.180 | -.043 | -.046 | -.526* | -.609* | -.176 | -.132 | -.358 | -.375 |
| 16 | .094 | .336 | .094 | -.047 | -.179 | -.262 | .173 | -.003 | -.053 |
| 17 | -.539* | .021 | -.136 | .121 | -.341 | -.222 | .008 | .045 | -.141 |
| 18 | -.240 | .033 | -.177 | .125 | .029 | -.018 | .077 | .279 | -.267 |
| 19 | -.245 | .321 | .056 | -.351 | -.623* | -.307 | .144 | -.523* | -.163 |
| 20 | -.151 | .253 | .123 | .190 | -.386 | .217 | .227 | -.319 | -.534* |
| 21 | -.479 | .147 | -.014 | -.019 | -.477 | -.216 | .226 | -.264 | -.295 |
| 22 | -.045 | .282 | .283 | -.209 | -.449 | .008 | .025 | -.326 | .126 |
| 23 | -.028 | .404 | .229 | -.2001 | -.309 | -.176 | .124 | -.144 | .087 |
| 24 | -.528* | -.254 | -.441 | -.453 | -.787** | -.489 | -.326 | -.407 | -.413 |
| 25 | .255 | +.346 | .249 | .206 | -.099 | .323 | .222 | -.262 | -.417 |
| 26 | -.109 | .486 | .264 | -.190 | -.471 | -.084 | .199 | -.461 | -.069 |
| 27 | .062 | .235 | .144 | -.117 | -.109 | -.052 | -.046 | .126 | .132 |
| 28 | -.263 | .281 | -.024 | -.091 | -.409 | -.108 | .191 | -.297 | -.363 |
| 29 | .282 | .407 | .303 | .252 | .267 | -.054 | .336 | .317 | .226 |

* Significant at 5% level
** Significant at 1% level

Table 7. Coefficients of correlation between the weekly rainfall and the yield of pepper

| Varieties | Standard weeks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -.07 | -.267 | .457 | -.248 | -.264 | .042 | .004 | -.109 | .312 |
| 2 | .185 | -.263 | .200 | -.408 | .143 | -.358 | .265 | .259 | .636* |
| 3 | -.016 | -.053 | .351 | -.404 | -.309 | -.181 | .206 | -.308 | .254 |
| 4 | -.174 | .206 | -.150 | .539* | .271 | .208 | -.547* | -.398 | -.407 |
| 5 | .129 | -.236 | .035 | -.272 | .375 | -.089 | .255 | .370 | .424 |
| 6 | .011 | -.235 | .172 | -.308 | -.041 | -.136 | .480 | .286 | .553* |
| 7 | -.006 | -.136 | -.244 | .025 | .697** | .076 | -.186 | .330 | .014 |
| 8 | .307 | -.391 | .467 | -.297 | -.075 | .095 | .452 | -.067 | .624* |
| 9 | -.029 | -.109 | -.218 | -.271 | .513 | -.179 | .103 | .426 | .169 |
| 10 | -.123 | -.149 | .438 | -.112 | -.236 | .519* | -.032 | -.374 | -.075 |
| 11 | .347 | -.098 | -.040 | -.017 | .279 | .279 | -.083 | -.143 | .104 |
| 12 | -.108 | -.194 | .050 | .109 | .325 | .375 | -.449 | -.391 | -.198 |
| 13 | .106 | -.337 | .043 | -.308 | .175 | -.099 | -.006 | .069 | .463 |
| 14 | -.138 | .287 | -.224 | -.196 | .277 | -.179 | -.021 | .206 | .292 |
| 15 | .102 | -.017 | .252 | -.057 | -.175 | -.183 | .130 | -.285 | .466 |
| 16 | -.007 | .036 | -.023 | .015 | .407 | .662** | -.236 | -.154 | -.265 |
| 17 | .067 | -.202 | .320 | -.453 | -.107 | .195 | .087 | -.369 | .059 |
| 18 | .045 | .234 | .119 | .124 | -.045 | .478 | -.225 | -.641** | -.332 |
| 19 | .215 | -.249 | .265 | -.271 | .191 | .192 | .345 | .164 | .448 |
| 20 | -.154 | .018 | .277 | -.227 | -.370 | -.257 | .062 | -.171 | .217 |
| 21 | .310 | -.361 | .378 | -.314 | -.012 | .541* | .158 | -.202 | .206 |
| 22 | -.019 | -.004 | .273 | -.253 | -.250 | .009 | .507 | -.059 | .212 |
| 23 | .123 | .036 | .143 | -.541* | .108 | -.009 | .50 | .226 | .290 |
| 24 | .23 | -.331 | .455 | -.422 | -.171 | .004 | .250 | -.360 | .444 |
| 25 | -.144 | .222 | -.088 | -.186 | -.123 | -.142 | .053 | .063 | .028 |
| 26 | .011 | -.264 | .107 | -.327 | .088 | .134 | .367 | .265 | .356 |
| 27 | -.002 | .268 | .158 | -.304 | -.114 | .104 | .327 | -.168 | .001 |
| 28 | -.080 | -.198 | .254 | -.075 | .009 | -.173 | -.025 | .080 | .388 |
| 29 | .087 | .273 | -.070 | -.103 | .409 | .613* | -.092 | .122 | -.329 |

* Significant at 5% level
** Significant at 1% level

Table 8. Coefficients of correlation between the weekly rainfall and the yield of pepper

| Varieties | Standard weeks 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -.245 | -.043 | -.120 | -.043 | -.259 | -.369 | .048 | .037 | -.089 |
| 2 | .358 | .047 | -.075 | .052 | -.085 | -.269 | .099 | .007 | -.180 |
| 3 | -.087 | -.177 | -.217 | .235 | -.273 | -.287 | .104 | .373 | -.006 |
| 4 | -.335 | -.038 | .296 | .243 | .019 | .054 | -.388 | -.068 | -.072 |
| 5 | .266 | .110 | .111 | -.302 | -.040 | -.145 | .225 | -.088 | -.329 |
| 6 | .207 | .034 | .086 | -.415 | -.343 | -.004 | .327 | -.279 | -.434 |
| 7 | .241 | .171 | .176 | -.256 | .252 | -.174 | -.040 | -.002 | -.103 |
| 8 | .091 | -.296 | -.086 | -.085 | -.496 | -.295 | .031 | .041 | -.243 |
| 9 | .329 | .232 | .068 | -.314 | .163 | -.173 | .198 | .092 | -.147 |
| 10 | -.056 | -.210 | .187 | -.009 | .105 | .168 | .364 | .234 | -.224 |
| 11 | .439 | -.152 | .003 | .143 | .456 | .196 | .087 | -.177 | -.273 |
| 12 | -.153 | -.041 | .152 | .130 | .171 | -.261 | -.131 | .286 | .089 |
| 13 | .437 | .115 | -.081 | -.080 | .155 | -.214 | .074 | -.168 | -.323 |
| 14 | .374 | -.315 | -.076 | -.035 | .202 | .004 | .032 | .242 | -.123 |
| 15 | .003 | -.325 | -.176 | .073 | -.467 | -.283 | -.210 | .048 | -.360 |
| 16 | -.017 | -.071 | .574** | .027 | .359 | .224 | .110 | .049 | -.456 |
| 17 | -.405 | -.097 | .096 | .378 | -.219 | -.452 | -.024 | .558* | .205 |
| 18 | -.251 | -.303 | .1433 | .296 | .149 | .232 | .047 | .036 | -.336 |
| 19 | .002 | -.059 | .256 | -.228 | -.256 | -.091 | .205 | -.164 | -.516* |
| 20 | .124 | .067 | .080 | .235 | -.003 | .146 | .245 | .006 | -.318 |
| 21 | -.293 | .012 | .473 | .011 | -.079 | -.037 | .209 | -.211 | -.580* |
| 22 | -.272 | -.106 | .187 | -.161 | -.603 | -.023 | .202 | .099 | -.346 |
| 23 | -.033 | -.124 | .039 | -.162 | -.232 | -.147 | .299 | .289 | -.288 |
| 24 | .039 | -.180 | .010 | .382 | -.338 | -.370 | -.081 | .311 | -.132 |
| 25 | .525* | .139 | .261 | .112 | .481 | .628* | .461 | -.184 | -.522* |
| 26 | .038 | .177 | .384 | -.399 | -.238 | .005 | .307 | -.205 | -.549* |
| 27 | -.170 | -.332 | -.030 | .015 | -.261 | .013 | .171 | .258 | -.258 |
| 28 | .037 | .021 | -.072 | -.132 | -.189 | -.249 | .001 | -.113 | -.201 |
| 29 | -.117 | -.175 | .312 | -.054 | .469 | .278 | .261 | .009 | -.277 |

* Significant at 5% level
** Significant at 1% level

Table 9. Coefficients of correlation between the weekly number of rainy days and the yield of pepper

| Varie- | Standard weeks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ties | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 1 | -.360 | -.221 | .719** | -.292 | -.202 | .114 | -.146 | .115 | -.048 |
| 2 | -.193 | -.242 | .309 | -.401 | -.018 | -.231 | .302 | .286 | .219 |
| 3 | -.065 | -.225 | .585* | -.401 | -.31 | -.172 | -.002 | .029 | -.236 |
| 4 | -.191 | .085 | .061 | .471 | .291 | .013 | -.565** | -.348 | -.498 |
| 5 | -.113 | -.219 | .091 | -.372 | .261 | .061 | .433 | .360 | .161 |
| 6 | -.100 | -.241 | .271 | -.351 | -.021 | -.049 | .458 | .266 | .274 |
| 7 | -.119 | -.077 | -.192 | -.123 | .510 | .228 | .176 | .264 | -.071 |
| 8 | -.022 | -.528* | .333 | -.252 | -.033 | .176 | .431 | .115 | .233 |
| 9 | -.035 | -.088 | -.069 | -.443 | .318 | .023 | .400 | .436 | -.021 |
| 10 | -.302 | -.191 | .278 | .029 | -.13 | .435 | -.141 | -.403 | -.226 |
| 11 | .243 | -.119 | -.389 | -.011 | .221 | .313 | .137 | -.187 | .202 |
| 12 | -.299 | -.167 | .063 | .124 | .229 | .270 | -.468 | -.286 | -.414 |
| 13 | -.074 | -.290 | .137 | -.442 | .076 | .098 | .147 | .190 | .213 |
| 14 | -.107 | .476 | -.215 | -.010 | .293 | -.262 | .221 | -.216 | .031 |
| 15 | -.140 | -.321 | .308 | -.259 | -.200 | -.123 | .086 | -.075 | .048 |
| 16 | -.149 | .118 | -.127 | .329 | .554* | .572* | .035 | -.380 | -.396 |
| 17 | -.174 | -.073 | .393 | .021 | .002 | .022 | -.169 | -.201 | -.422 |
| 18 | .154 | .013 | .159 | .140 | .134 | .335 | -.313 | -.420 | -.471 |
| 19 | -.116 | -.237 | .298 | -.172 | .293 | .244 | .396 | .175 | .088 |
| 20 | -.323 | -.076 | .529* | -.203 | -.341 | -.288 | -.202 | -.189 | -.114 |
| 21 | -.140 | -0.79 | .261 | .101 | .345 | .569* | .064 | -.189 | -.041 |
| 22 | -.014 | -.19 | .454 | -.158 | -.037 | -.025 | .031 | .099 | -.170 |
| 23 | .168 | -.002 | .356 | -.412 | .195 | .091 | .617* | .357 | -.141 |
| 24 | -.139 | -.466 | .446 | -.174 | -.103 | .002 | .083 | -.115 | -.116 |
| 25 | -.043 | .225 | -.014 | -.074 | -.095 | -.162 | .052 | -.214 | 0 |
| 26 | -.151 | -.149 | .219 | -.174 | .254 | .190 | .383 | .187 | .087 |
| 27 | .289 | .031 | .412 | -.245 | .052 | .125 | .351 | .089 | -.083 |
| 28 | -.363 | -.243 | .535* | -.304 | -.082 | .061 | -.063 | .210 | .051 |
| 29 | .179 | .450 | -.094 | .187 | .560* | .575* | .225 | .082 | -.315 |

* Significant at 5% level
** Significant at 1% level

Table 10. Coefficients of correlation between the weekly number of rainy days and the yield of pepper

| Varieties | Standard weeks 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .079 | .295 | .184 | -.107 | -.202 | -.434 | .177 | -.268 | -.027 |
| 2 | .124 | .309 | .121 | -.225 | -.322 | -.139 | .157 | -.353 | -.141 |
| 3 | -.143 | .139 | .367 | -.055 | -.098 | -.488 | -.078 | -.153 | -.047 |
| 4 | -.256 | .169 | .079 | .275 | -.031 | -.496 | .183 | -.121 | -.047 |
| 5 | .135 | .357 | .167 | -.220 | -.429 | .119 | .318 | -.427 | -.205 |
| 6 | .189 | .338 | .109 | -.479 | -.696** | .345 | .226 | -.582* | -.449 |
| 7 | .093 | .388 | .164 | .146 | -.047 | -.105 | .235 | -.180 | .096 |
| 8 | .012 | .202 | .275 | -.159 | -.379 | .031 | -.280 | -.396 | -.063 |
| 9 | .117 | .382 | .227 | .057 | -.170 | -.037 | .316 | -.240 | -.010 |
| 10 | .038 | .111 | .328 | .011 | -.227 | .254 | .164 | -.159 | -.137 |
| 11 | .133 | -.189 | .247 | .176 | .233 | .220 | -.045 | .139 | .098 |
| 12 | -.207 | .290 | .332 | .234 | .070 | -.446 | .201 | -.059 | .187 |
| 13 | .277 | .324 | .385 | -.074 | -.072 | -.211 | .137 | -.214 | -.033 |
| 14 | -.008 | .033 | -.220 | -.556* | -.349 | .309 | .303 | .023 | -.392 |
| 15 | -.010 | .107 | .249 | -.321 | -.501 | -.141 | -.115 | -.274 | -.344 |
| 16 | -.148 | .228 | .297 | .083 | -.081 | .114 | .283 | -.006 | -.235 |
| 17 | -.534* | .168 | .244 | -.083 | .089 | -.575* | .008 | .111 | .098 |
| 18 | -.219 | -.129 | .435 | .275 | .141 | -.296 | .123 | .059 | .005 |
| 19 | -.001 | .330 | .200 | -.279 | -.533* | .109 | .251 | -.477 | -.349 |
| 20 | .109 | .199 | .198 | -.205 | -.373 | -.103 | .316 | -.299 | -.395 |
| 21 | -.184 | .175 | .299 | -.234 | -.230 | .024 | .262 | -.125 | -.366 |
| 22 | -.195 | .230 | .205 | -.320 | -.576* | .044 | .040 | -.427 | -.389 |
| 23 | -.134 | .205 | .250 | -.195 | -.229 | -.120 | .152 | -.222 | -.106 |
| 24 | -.212 | .260 | .451 | -.031 | -.126 | -.422 | -.287 | -.169 | -.012 |
| 25 | .268 | .037 | .130 | -.190 | -.232 | .432 | .399 | -.117 | -.050 |
| 26 | .050 | .439 | .180 | -.442 | -.604* | .256 | .327 | -.468 | -.515* |
| 27 | -.598 | .053 | .370 | .044 | -.059 | -.277 | -.057 | -.113 | .005 |
| 28 | .208 | .384 | .135 | -.109 | -.397 | -.292 | .262 | -.474 | -.139 |
| 29 | -.117 | -.078 | .053 | .174 | .239 | .092 | .341 | .207 | .038 |

* Significant at 5% level
** Significant at 1% level

Table 11. Coefficients of correlation between the fortnightly maximum temperature and the yield of pepper

| Varieties | Fortnights 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .269 | .281 | .441 | .394 | .029 | .045 | .259 | .264 | -.151 |
| 2 | .231 | .428 | .623* | .158 | -.303 | .286 | .170 | .164 | -.124 |
| 3 | .098 | .385 | .497 | .411 | .065 | .262 | .032 | .122 | .255 |
| 4 | .359 | -.348 | .021 | .588* | .576* | .204 | .198 | .188 | .135 |
| 5 | .128 | .286 | .324 | -.043 | -.150 | .009 | .233 | .243 | -.146 |
| 6 | .081 | .345 | .340 | -.125 | -.241 | -.150 | .422 | .093 | .022 |
| 7 | .171 | .032 | .983 | .044 | .080 | .080 | .037 | .171 | -.314 |
| 8 | .153 | .445 | .334 | .086 | -.153 | .029 | .308 | -.193 | .119 |
| 9 | -.006 | .196 | .210 | -.096 | -.105 | .037 | -.016 | .254 | -.213 |
| 10 | .312 | .268 | .137 | .384 | .453 | .045 | .164 | -.009 | .216 |
| 11 | .367 | .289 | .218 | .224 | .076 | .069 | -.082 | -.20 | -.103 |
| 12 | .618* | .259 | .359 | .771** | .682** | .518* | .290 | .080 | .042 |
| 13 | .448 | .506 | .655** | .361 | .148 | .127 | .131 | .032 | -.343 |
| 14 | .197 | .296 | .301 | .148 | -.059 | .263 | .205 | .114 | -.067 |
| 15 | .045 | .273 | .354 | .311 | -.190 | .025 | .206 | .048 | .074 |
| 16 | .224 | -.236 | -.215 | .229 | .551* | -.144 | -.010 | .169 | .098 |
| 17 | .205 | .215 | .246 | .463 | .468 | .464 | .151 | .123 | .401 |
| 18 | .252 | -.075 | .047 | .553* | .577* | -.076 | -.062 | .141 | .312 |
| 19 | .143 | .149 | .200 | .009 | -.008 | -.176 | .341 | .244 | .039 |
| 20 | .202 | .18 | .502 | .379 | -.009 | .140 | .076 | .251 | .145 |
| 21 | .28 | .017 | .037 | .213 | .341 | -.245 | .284 | .238 | .129 |
| 22 | -.271 | -.045 | -.060 | -.150 | .011 | -.270 | .202 | .159 | .434 |
| 23 | -.268 | .066 | .033 | -.222 | -.104 | -.255 | -.064 | .306 | .160 |
| 24 | .233 | .367 | .456 | .426 | .068 | .333 | .084 | -.130 | .292 |
| 25 | .099 | .013 | .217 | .040 | -.065 | -.124 | -.171 | .135 | .069 |
| 26 | .045 | 0.75 | .092 | -.148 | -.029 | -.298 | .350 | .217 | .029 |
| 27 | -.292 | -.079 | -.088 | -.035 | .086 | -.320 | -.205 | .158 | .338 |
| 28 | .319 | .273 | .540* | .351 | -.102 | .111 | .314 | .271 | -.231 |
| 29 | -.066 | -.363 | -.419 | -.131 | .348 | -.402 | -.261 | .339 | -.028 |

* Significant at 5% level
** Significant at 1% level

Table 12. Coefficients of correlation between the fortnightly minimum temperature and the yield of pepper

| Varie- | Fortnightly | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ties | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 1 | .102 | -.131 | .284 | .112 | -.226 | -.085 | -.092 | .212 | -.223 |
| 2 | -.298 | -.052 | .076 | .392 | -.079 | .280 | .089 | .095 | -.201 |
| 3 | -.090 | -.204 | .022 | -.099 | -.217 | -.273 | -.494 | .036 | .007 |
| 4 | .291 | -.178 | -.152 | .076 | .347 | -.074 | .159 | .174 | -.039 |
| 5 | -.293 | .015 | .025 | .565* | .163 | .312 | .265 | .201 | -.054 |
| 6 | -.475 | -.108 | .076 | .138 | -.197 | -.035 | .001 | .050 | -.145 |
| 7 | .124 | .086 | -.082 | .793** | .569* | .520* | .500 | .164 | .018 |
| 8 | -.215 | -.226 | -.248 | .081 | -.166 | .001 | -.131 | -.292 | -.093 |
| 9 | -.084 | .121 | .037 | .687** | .345 | .368 | .251 | .235 | .092 |
| 10 | -.392 | -.444 | -.162 | -.069 | .221 | -.302 | -.183 | -.020 | -.202 |
| 11 | -.351 | .089 | -.253 | .617* | .484 | .576* | .415 | -.203 | -.064 |
| 12 | .088 | .074 | -.015 | .407 | .658** | .221 | .309 | .045 | -.260 |
| 13 | -.174 | .149 | .151 | .807** | .225 | .559* | .369 | -.007 | -.245 |
| 14 | -.603* | -.102 | -.216 | .261 | .141 | .298 | .009 | .091 | -.142 |
| 15 | -.166 | -.361 | -.223 | .062 | -.37 | -.074 | -.373 | -.040 | .015 |
| 16 | -.238 | -.333 | -.432 | .339 | .630* | -.006 | .147 | .170 | .011 |
| 17 | -.032 | .091 | .016 | -.307 | .087 | -.333 | -.316 | .039 | -.145 |
| 18 | -.088 | -.296 | -.325 | .110 | .302 | -.158 | -.171 | .108 | .169 |
| 19 | -.338 | -.184 | -.119 | .293 | .024 | .030 | .092 | .178 | -.053 |
| 20 | -.398 | -.398 | .130 | -.120 | -.261 | -.312 | -.327 | .225 | -.214 |
| 21 | -.347 | -.004 | -.007 | .118 | .146 | -.109 | .132 | .196 | -.185 |
| 22 | -.209 | -.370 | -.173 | -.43 | -.381 | -.641* | -.565* | .091 | .177 |
| 23 | -.180 | -.190 | -.202 | .133 | -.099 | -.178 | -.341 | .232 | .316 |
| 24 | -.138 | -.265 | -.240 | -.073 | -.095 | -.191 | -.364 | -.241 | -.141 |
| 25 | -.696** | -.358 | -.066 | .113 | .056 | -.090 | -.097 | .173 | -.095 |
| 26 | -.380 | -.063 | .056 | .165 | -.013 | -.116 | .071 | .187 | -.113 |
| 27 | -.008 | -.443 | -.417 | -.098 | -.137 | -.423 | -.422* | .086 | .457 |
| 28 | .009 | -.191 | .195 | .367 | -.116 | .144 | .106 | .223 | -.217 |
| 29 | -.100 | -.190 | -.352 | .352 | .485 | .083 | .126 | .355 | .301 |

* Significant at 5% level
** Significant at 1% level

Table 13. Coefficients of correlation between the fortnightly relative humidity and the yield of pepper

| Varie-ties | Fortnights 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -.539* | -.411 | -.412 | -.572* | -.210 | .130 | -.154 | .172 | -.267 |
| 2 | -.312 | -.156 | -.404 | -.078 | -.034 | .021 | -.540* | .012 | -.622* |
| 3 | -.415 | -.152 | -.353 | -.446 | -.257 | -.027 | -.276 | -.055 | -.271 |
| 4 | -.122 | -.183 | -.055 | -.496 | -.421 | .046 | .196 | .169 | .209 |
| 5 | -.068 | -.089 | -.049 | .172 | .086 | .240 | -.486 | .129 | -.440 |
| 6 | -.315 | -.215 | -.183 | .147 | .197 | .309 | -.521* | .040 | -.552* |
| 7 | .309 | .138 | .308 | .228 | .051 | .161 | -.208 | .083 | -.022 |
| 8 | -.295 | -.167 | -.182 | -.110 | .004 | -.263 | -.849** | -.406 | -.574* |
| 9 | .241 | .191 | .222 | .333 | .141 | .304 | -.243 | .150 | -.133 |
| 10 | -.285 | -.359 | -.085 | -.302 | -.144 | .090 | -.279 | -.003 | -.381 |
| 11 | .061 | -.243 | -.111 | -.205 | -.358 | -.379 | -.264 | -.216 | -.351 |
| 12 | -.219 | -.334 | -.077 | -.497 | -.589* | -.075 | -.117 | .018 | -.098 |
| 13 | -.211 | -.306 | -.326 | -.311 | -.336 | -.092 | -.379 | -.054 | -.518* |
| 14 | -.323 | -.342 | -.251 | .005 | .376 | .466 | -.158 | .104 | -.245 |
| 15 | -.339 | -.256 | -.439 | -.436 | .069 | -.047 | -.634* | -.146 | -.462 |
| 16 | .033 | -.182 | .268 | -.095 | -.123 | .257 | -.134 | .138 | -.031 |
| 17 | -.51 | -.240 | -.198 | -.390 | -.481 | -.044 | -.151 | -.017 | -.049 |
| 18 | -.209 | -.345 | -.117 | -.678** | -.556* | -.054 | .080 | .072 | .044 |
| 19 | -.313 | -.285 | -.122 | -.032 | .001 | .232 | -.558* | .104 | -.457 |
| 20 | -.478 | -.3 | -.543* | -.416 | -.170 | .216 | -.146 | .241 | -.518* |
| 21 | -.503 | -.582* | -.221 | -.380 | -.469 | .089 | -.304 | .192 | -.351 |
| 22 | -.242 | .021 | .027 | .068 | .191 | .303 | -.380 | .025 | -.156 |
| 23 | -.096 | .081 | .134 | .161 | .202 | .359 | -.289 | .099 | -.051 |
| 24 | -.380 | -.124 | -.31 | -.393 | -.331 | -.352 | -.708** | -.367 | -.518* |
| 25 | -.104 | -.151 | -.226 | -.022 | -.030 | -.330 | .039 | .248 | -.418 |
| 26 | -.250 | -.207 | .002 | .165 | .092 | .427 | -.385 | .181 | -.361 |
| 27 | -.045 | .127 | .186 | -.102 | .106 | .213 | -.125 | -.05 | .163 |
| 28 | -.378 | -.302 | -.391 | -.344 | -.074 | .172 | -.298 | .171 | -.413 |
| 29 | .128 | -.084 | .383 | .068 | .060 | .392 | .288 | .316 | .350 |

* Significant at 5% level
** Significant at 1% level

Table 14. Coefficients of correlation between the fortnightly rainfall and the yield of pepper

| Varieties | Fortnights 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -.185 | -.12 | -.085 | -.092 | .013 | -.093 | -.181 | -.210 | -.007 |
| 2 | .048 | -.362 | -.232 | .298 | .576* | -.014 | -.073 | -.120 | -.065 |
| 3 | -.038 | -.313 | -.291 | -.206 | .082 | -.227 | -.012 | -.129 | .280 |
| 4 | -.065 | .513 | .297 | -.497 | -.436 | .143 | .167 | -.162 | -.079 |
| 5 | .011 | -.271 | .096 | .391 | .401 | .127 | -.217 | .023 | -.195 |
| 6 | -.097 | -.268 | -.131 | .383 | .434 | .068 | -.469 | .164 | -.304 |
| 7 | -.067 | -.048 | .381 | .231 | .162 | .201 | -.014 | -.131 | -.042 |
| 8 | .102 | -.168 | .045 | .071 | .398 | -.224 | -.349 | -.172 | -.064 |
| 9 | -.075 | -.346 | .085 | .395 | .302 | .176 | -.103 | -.009 | .012 |
| 10 | -.179 | .016 | .324 | -.330 | -.076 | -.020 | .057 | .292 | .089 |
| 11 | .271 | -.030 | .358 | -.147 | .338 | -.088 | .362 | .169 | -.24 |
| 12 | -.186 | .128 | .459 | -.464 | -.206 | .060 | .184 | -.232 | .251 |
| 13 | -.056 | -.306 | -.003 | .058 | .532* | .023 | 0.41 | -.098 | -.252 |
| 14 | .004 | -.271 | -.023 | .171 | .399 | -.229 | .098 | .018 | -.134 |
| 15 | .085 | .016 | -.232 | -.208 | .255 | -.292 | -.231 | -.287 | -.104 |
| 16 | .009 | .009 | .735** | -.199 | -.155 | .279 | .231 | .198 | -.140 |
| 17 | -.031 | -.373 | .113 | -.292 | -.228 | -.004 | .112 | -.299 | .501 |
| 18 | .146 | .164 | .376 | -.614* | -.342 | -.10 | .277 | .170 | -.103 |
| 19 | .083 | -.201 | .247 | .239 | .245 | .108 | -.298 | .047 | -.324 |
| 20 | -.132 | -.152 | -.382 | -.129 | .198 | .085 | .148 | .217 | -.119 |
| 21 | .119 | -.212 | .526* | -.128 | -.076 | .272 | -.039 | .083 | -.385 |
| 22 | -.019 | -.180 | -.106 | .094 | -.059 | .042 | -.461 | .088 | -.060 |
| 23 | .128 | -.513 | .042 | .336 | .137 | -.052 | -.241 | .059 | .031 |
| 24 | .059 | -.301 | -.075 | -.238 | .267 | -.101 | .043 | -.276 | .183 |
| 25 | -.031 | -.219 | -.174 | .069 | .352 | .228 | .358 | .634* | -.342 |
| 26 | -.110 | -.307 | .151 | .332 | .214 | .32 | -.396 | .159 | -.368 |
| 27 | .119 | -.267 | .034 | -.051 | -.109 | -.215 | -.146 | .095 | .095 |
| 28 | -.162 | -.001 | -.139 | .062 | .235 | -.028 | -.190 | -.157 | -1.64 |
| 29 | .203 | -.217 | .695** | .079 | -.254 | .071 | .245 | .309 | -.100 |

* Significant at 5% level
** Significant at 1 % level

Table 15. Coefficients of correlation between the fortnightly number of rainy days and the yield of pepper

| Varieties | Fortnights 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -.353 | .361 | -.060 | .006 | .003 | .291 | -.178 | -.033 | -.203 |
| 2 | -.276 | -.059 | -.147 | .326 | .196 | .263 | -.317 | .072 | -.337 |
| 3 | -.194 | .169 | -.296 | .018 | -.215 | .302 | -.088 | -.209 | -.075 |
| 4 | -.045 | .409 | .190 | -.532* | -.434 | .151 | .120 | -.053 | -.114 |
| 5 | -.216 | -.21 | .199 | .435 | .164 | .320 | -.375 | .313 | -.43 |
| 6 | -.224 | -.048 | -.042 | .386 | .260 | .274 | -.67** | .330 | -.698** |
| 7 | -.120 | -.251 | .453 | .253 | -.006 | .337 | .045 | .151 | -.062 |
| 8 | -.382 | .078 | .083 | .276 | .156 | .287 | -.314 | -.218 | -.315 |
| 9 | -.081 | -.395 | .213 | .469 | .038 | .370 | -.133 | .247 | -.172 |
| 10 | -.301 | .248 | .173 | -.326 | -.129 | .261 | -.134 | .241 | -.200 |
| 11 | .050 | -.324 | .322 | -.056 | .189 | .027 | .233 | .053 | .160 |
| 12 | -.282 | .146 | .303 | -.404 | -.359 | .374 | .161 | -.018 | .082 |
| 13 | -.244 | -.226 | .105 | .191 | .259 | .427 | -.081 | .026 | -.170 |
| 14 | .274 | -.183 | -.129 | -.036 | .017 | -.109 | -.496 | .379 | -.242 |
| 15 | -.302 | .053 | -.197 | -.008 | .027 | .213 | -.470 | -.153 | -.416 |
| 16 | .001 | .148 | .683** | -.261 | -.321 | .316 | -.008 | .281 | -.159 |
| 17 | -.147 | .336 | .014 | -.208 | -.506 | .242 | .013 | -.231 | .142 |
| 18 | .094 | .236 | .280 | -.417 | -.401 | .175 | .226 | -.020 | .044 |
| 19 | -.231 | .111 | .327 | .298 | .056 | .322 | -.469 | .253 | -.560* |
| 20 | -.231 | .274 | -.383 | -.184 | -.269 | .239 | -.333 | .219 | -.467 |
| 21 | -.203 | .289 | .550 | -.091 | -.107 | .284 | -.250 | .227 | -.327 |
| 22 | -.141 | .249 | -.038 | .209 | -.195 | .263 | -.516* | .051 | -.551* |
| 23 | .091 | -.025 | .176 | .519* | -.150 | .274 | -.239 | .076 | -.223 |
| 24 | -.403 | .229 | -.064 | -.035 | -.168 | .426 | -.093 | -.413 | -.125 |
| 25 | .134 | -.068 | -.154 | -.113 | .117 | .099 | -.239 | .509 | -.408 |
| 26 | -.188 | .046 | .271 | .300 | .079 | .378 | -.595* | .377 | -.663** |
| 27 | .182 | .145 | .106 | .222 | -.334 | .249 | -.014 | -.162 | -.075 |
| 28 | -.371 | .203 | -.087 | .106 | .124 | .321 | -.299 | .096 | -.420 |
| 29 | .414 | .066 | .689** | .053 | -.255 | -.017 | .235 | .321 | .168 |

*Significant at 5% level
**Significant at 1% level

Table 16. Estimated 1st stage regression models from weekly weather parameters of group 1 for variety 1

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .07045 | -.26733 | -.0089 | -.0503 | -.2728 |
| 16 | -1.10168 | -.20236 | -.2413 | .0177 | .2291 |
| 17 | -.11142 | -.13166 | .2427 | .0874 | 1.0190 |
| 18 | -.08476 | -.24613 | -.0758 | -.0071 | -1.0026 |
| 19 | .87484 | .69259 | .0348 | .0285 | .6961 |
| 20 | -.04529 | .21226 | -.0311 | -.0087 | -.2318 |
| 21 | .41378 | -.5052 | -.1384 | 0 | -.4362 |
| 22 | .08786 | .72967 | -.0324 | -.0059 | -.4191 |
| 23 | -.28958 | -.46754 | .1378 | .0039 | .1721 |
| Intercept | 20.06575 | 15.34805 | 11.4830 | .4401 | 2.5712 |
| $R^2$ | .662595 | .70392 | .57456 | .53144 | .8354 |

Table 17. Estimated 1st stage regression models from weekly weather parameters of group II variety 1

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | 0 | -.1437 | -.287 | 0 | .5725 |
| 25 | -.1010 | .7153 | .4721 | -.0021 | -.4105 |
| 26 | 0 | -.4403 | .3744 | 0 | .3408 |
| 27 | 0 | -.6005 | .3497 | 0 | -.8547 |
| 28 | .3500 | .1992 | .0276 | -.0012 | -1.0725 |
| 29 | .1571 | 1.0092 | .1223 | -.0074 | -1.9017 |
| 30 | 0 | -2.0989 | -.9029 | .0061 | .2854 |
| 31 | -.2551 | -.5624 | .2338 | -.0020 | -.1024 |
| 32 | 0 | .8064 | -.1023 | -.0046 | .5497 |
| Intercept | -11.0075 | 82.3245 | -27.0285 | 3.8684 | 18.4872 |
| $R^2$ | .2200 | .6006 | .7552 | .3672 | .7056 |

Table 18. Estimated 1st stage regression models from weekly weather parameters of group I variety 2

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .19404 | -.19574 | -.0999 | -.0163 | -.5902 |
| 16 | -.54957 | .16941 | .0356 | -.0026 | -.1127 |
| 17 | -.03823 | -.12298 | .0397 | .0298 | .2875 |
| 18 | .05231 | .20431 | -.0321 | -.0043 | -.4545 |
| 19 | .25677 | -.09808 | 0 | .0226 | .4716 |
| 20 | .10015 | .11774 | -.0576 | -.0083 | -.3846 |
| 21 | .01998 | -.15497 | .1217 | .0014 | .2238 |
| 22 | .00983 | .18926 | -.0218 | -.0026 | -.2999 |
| 23 | -.13037 | -.07226 | 0 | .0029 | .1161 |
| Intercept | 9.00211 | -2.01896 | 2.2587 | .3632 | 1.9608 |
| $R^2$ | .829921 | .61152 | .44356 | .8372 | .9120 |

Table 19. Estimated 1st stage regression models from weekly weather parameters of group II for variety 2

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.1420 | .0774 | -.0788 | .0035 | .0964 |
| 25 | .1845 | .5295 | .1841 | -.001 | 0 |
| 26 | -.2138 | .0624 | .3312 | .0013 | .0819 |
| 27 | -.0772 | -.7713 | -.0237 | .0010 | -.3513 |
| 28 | .299 | .1079 | .3822 | -.0015 | 0 |
| 29 | .245 | .4183 | -.2470 | -.0039 | -.3848 |
| 30 | -.2164 | -1.2321 | -.2500 | .0039 | .0759 |
| 31 | -.1390 | -.2421 | -.2470 | -.0008 | -.2305 |
| 32 | .0149 | .5391 | -.2567 | -.0013 | 0 |
| Intercept | 4.9409 | 37.7206 | 20.6676 | .6590 | 5.5683 |
| $R^2$ | .8100 | .8519 | .7921 | .6053 | .3782 |

Table 20. Estimated 1st stage regression models from weekly weather parameters of group I for variety 3

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | -.03576 | -.4863 | -.3340 | -.0586 | -.0651 |
| 16 | -1.09529 | .41708 | -.3276 | .0236 | -.2882 |
| 17 | -.09707 | -.16247 | .3986 | .0912 | .8461 |
| 18 | .06502 | .29837 | .1468 | -.0124 | -.7958 |
| 19 | .70903 | .04587 | -.0650 | .0413 | .3774 |
| 20 | .15938 | .15639 | .1994 | -.0177 | -.5221 |
| 21 | .18510 | -.61988 | -.3324 | .0129 | .1349 |
| 22 | .12041 | .47498 | .0501 | -.0121 | -.6046 |
| 23 | -.13423 | 0 | .1425 | .0021 | -.1633 |
| Intercept | 16.33898 | -6.77732 | 12.8597 | 2.1679 | 5.9586 |
| $R^2$ | .81360 | .50837 | .6989 | .8649 | .8798 |

Table 21. Estimated 1st stage regression models from weekly weather parameters of group II for variety 3

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0664 | -.1706 | -.2298 | .002 | .1644 |
| 25 | .0460 | .6730 | .4113 | .0012 | -.5780 |
| 26 | 0 | -.4006 | -.0061 | -.0031 | .7580 |
| 27 | -.2287 | -1.1800 | .2055 | .0036 | -1.2674 |
| 28 | .3977 | -.3226 | -.5279 | .0051 | -.5099 |
| 29 | .2746 | 1.1742 | .3833 | -.0027 | -1.4089 |
| 30 | -.0846 | -1.6237 | -.7434 | .0053 | .0727 |
| 31 | -.1361 | -.02 | .5401 | .0053 | -.4627 |
| 32 | 0 | -.4273 | .1495 | -.0075 | .6570 |
| Intercept | -14.4755 | 169.4691 | -15.2653 | 2.2361 | 19.0703 |
| $R^2$ | .4409 | .8836 | .8010 | .6052 | .6642 |

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Table 22. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 4

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .02202 | .2295 | .2114 | -.0075 | .3257 |
| 16 | -.00394 | -.09158 | .0183 | .0099 | .0478 |
| 17 | -.0655 | -.0119 | -.1307 | .0162 | .1949 |
| 18 | -.07056 | 0 | .0916 | .0026 | -.0815 |
| 19 | -.00707 | -.0469 | .0279 | .0100 | .2590 |
| 20 | .04439 | .0888 | -.1357 | -.0011 | -.0776 |
| 21 | .07878 | -.1460 | .0557 | -.0031 | -.4345 |
| 22 | .03100 | .1296 | -.1785 | -.0019 | -.0350 |
| 23 | .01806 | .0807 | -.0804 | .0000 | .0370 |
| Intercept | -3.39728 | -16.8404 | 11.7992 | .2770 | .6772 |
| $R^2$ | .7744 | .53876 | .7850 | .6257 | .8556 |

Table 23. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 4

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | .0658 | .0630 | -.0560 | -.002 | .0690 |
| 25 | -.0257 | 0 | .06192 | .0001 | -.0515 |
| 26 | .0432 | 0 | 0 | 0 | -.2033 |
| 27 | 0 | -.3764 | .1227 | .0001 | .7321 |
| 28 | 0 | .2216 | 0 | .0009 | -.4776 |
| 29 | -.0947 | 0 | 0 | .0014 | -.5896 |
| 30 | .0724 | -.0646 | -.1220 | -.0027 | .0681 |
| 31 | 0 | .2106 | .1072 | -.0004 | .1787 |
| 32 | 0 | -.2978 | 0 | 0 | -.2753 |
| Intercept | -4.6776 | 18.3306 | -10.5460 | 1.0361 | 3.8759 |
| $R^2$ | .3422 | .3894 | .3125 | .4747 | .7140 |

Table 24. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 5

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .50862 | -.1507 | 0 | -.0291 | -.8155 |
| 16 | -.78639 | -.4365 | .0414 | -.0140 | -.1137 |
| 17 | .01682 | -.0134 | 0 | .0182 | .1561 |
| 18 | .22201 | -.1955 | -.1739 | -.0024 | -.5087 |
| 19 | .20085 | .2522 | 0 | .0311 | .5627 |
| 20 | .08474 | -.1257 | 0 | -.0016 | -.2595 |
| 21 | -.19696 | .0431 | .2210 | .0117 | .3653 |
| 22 | -.0435 | .2804 | 0 | -.0021 | -.2279 |
| 23 | -.11226 | -.2964 | .0208 | .0036 | .1110 |
| Intercept | 11.21845 | 50.5412 | -7.8433 | .71672 | 2.5797 |
| $R^2$ | .64481 | .61309 | .2759 | .61623 | .7586 |

Table 25. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 5

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.1783 | .4422 | -.0549 | .0040 | 0 |
| 25 | .2364 | .4680 | .3678 | -.0033 | .2365 |
| 26 | -.3960 | .2926 | .2436 | .0042 | .4092 |
| 27 | .1077 | -.9170 | -.2515 | -.0018 | -.6198 |
| 28 | .2647 | .1471 | .5080 | -.0005 | -.0898 |
| 29 | .2501 | .2572 | -.3880 | -.0054 | .1873 |
| 30 | -.2141 | -1.8287 | -.1380 | .0053 | .2097 |
| 31 | -.1904 | -.5451 | -.3640 | -.0009 | -.2821 |
| 32 | .1121 | 1.5490 | -.2682 | -.0031 | .4126 |
| Intercept | 3.0182 | 10.7449 | 35.4161 | 2.4491 | -.5958 |
| $R^2$ | .810 | .8172 | .9624 | .6496 | .5141 |

Table 26. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 6

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .59751 | -.3569 | -.1663 | -.0404 | -.8203 |
| 16 | -.90952 | -.5071 | 0 | -.0092 | -.2071 |
| 17 | .04051 | .0385 | .0845 | .0074 | .2173 |
| 18 | .27861 | -.3824 | -.1794 | -.0006 | -.3195 |
| 19 | .21254 | .4515 | .0689 | .0200 | .3141 |
| 20 | .09643 | -.0639 | 0 | .0030 | -.3058 |
| 21 | -.2693 | -.0254 | .0941 | .0218 | .5848 |
| 22 | -.06167 | .2839 | .1026 | -.0030 | -.3061 |
| 23 | -.11128 | -.4214 | .0680 | .0051 | .0637 |
| Intercept | 12.3150 | 75.8671 | -5.3418 | -.0457 | 2.1377 |
| $R^2$ | .91394 | .5914 | .4872 | .6989 | .6889 |

Table 27. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 6

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.2192 | .2294 | -.0557 | .0044 | -.1511 |
| 25 | .2292 | .6262 | .2949 | -.0030 | .1833 |
| 26 | -.4161 | -.2113 | .1101 | .0041 | .4399 |
| 27 | .0702 | -.2529 | -.2234 | -.0017 | -1.1270 |
| 28 | .4118 | 0 | -.0690 | -.0029 | .4398 |
| 29 | .2107 | .3222 | .0138 | -.0039 | .4773 |
| 30 | -.2460 | -1.7544 | -.0989 | .0060 | .0728 |
| 31 | -.1116 | -.5655 | -.1838 | .0003 | -.6885 |
| 32 | .1273 | 1.5412 | -.0073 | -.0040 | .2606 |
| Intercept | -2.705 | 5.3709 | 22.7986 | 1.7381 | 2.1256 |
| $R^2$ | .8538 | .5446 | .9370 | .8817 | .8010 |

Table 28. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 7

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .20734 | .3281 | 0 | -.0212 | -.5861 |
| 16 | 0 | -.4018 | .0821 | -.0188 | .0444 |
| 17 | 0 | -.0760 | -.1006 | .0143 | -.0808 |
| 18 | 0 | -.0025 | 0 | -.0006 | -.8683 |
| 19 | 0 | -.0135 | 0 | .0357 | .5411 |
| 20 | 0 | -.2367 | .0952 | -.0007 | -.0132 |
| 21 | -.15372 | .1617 | 0 | .0018 | 0 |
| 22 | 0 | .1934 | 0 | -.0001 | .0654 |
| 23 | 0 | -.0726 | 0 | .0015 | .0755 |
| Intercept | -4.55097 | 10.2677 | -5.9263 | .1077 | .9588 |
| $R^2$ | .09 | .8010 | .1945 | .6626 | .5655 |

Table 29. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 7

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0880 | .6876 | .0059 | .0023 | 0 |
| 25 | .1984 | -.3435 | .4272 | -.0029 | .4891 |
| 26 | -.311 | 1.0404 | .1863 | .0039 | .24 |
| 27 | .2345 | -1.5434 | -.2573 | -.0034 | 0 |
| 28 | -.0524 | .3985 | .9744 | .0028 | -.1907 |
| 29 | .0842 | -.0737 | -.7159 | -.0033 | .1804 |
| 30 | .0127 | -.9381 | -.1577 | 0 | .2612 |
| 31 | -.2240 | -.4523 | -.3952 | 0 | 0 |
| 32 | .0972 | .9151 | -.3768 | -.0013 | .4308 |
| Intercept | 5.1735 | 22.3807 | 31.1292 | 1.8053 | -7.4683 |
| $R^2$ | .7123 | .9781 | .9584 | .4476 | .3648 |

Table 30. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 8

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .30225 | -.2834 | -.1616 | -.0227 | -.2952 |
| 16 | -.51916 | .0478 | -.0411 | -.0110 | -.3927 |
| 17 | .03636 | -.0360 | .0892 | .0174 | .1340 |
| 18 | .15299 | .0099 | -.0476 | .0002 | -.0747 |
| 19 | .16308 | .0558 | 0 | .0177 | .0922 |
| 20 | -.02231 | -.1892 | .1171 | .0005 | -.1153 |
| 21 | -.13473 | -.0594 | 0 | .0137 | .4305 |
| 22 | .04795 | .1503 | 0 | -.0042 | -.2262 |
| 23 | -.14354 | -.2063 | .0969 | .0035 | -.0051 |
| Intercept | 11.34090 | 39.5953 | -4.1579 | .01206 | 1.5992 |
| $R^2$ | .9370 | .7517 | .3994 | .87049 | .7921 |

Table 31. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 8

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0635 | 0 | -.0240 | .003 | -.1279 |
| 25 | .1024 | .5836 | .1448 | -.0029 | .0022 |
| 26 | -.1688 | -.3273 | -.0078 | .0026 | .3863 |
| 27 | -.0118 | -.0316 | -.1591 | 0 | -.5907 |
| 28 | .2436 | .2069 | -.2082 | -.0024 | -.2005 |
| 29 | .1336 | .4312 | .0580 | -.0035 | .1769 |
| 30 | -.0462 | -.7864 | -.1089 | .0037 | -.1206 |
| 31 | -.08280 | -.3465 | .0366 | .0003 | -.2509 |
| 32 | .0063 | .5963 | .0975 | -.0015 | .4316 |
| Intercept | -8.3120 | -22.8691 | 24.5279 | 1.4660 | 2.9798 |
| $R^2$ | .7022 | .5565 | .9158 | .8949 | .6675 |

Table 32. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 9

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .1484 | .0216 | 0 | -.0166 | -.4710 |
| 16 | -.2414 | -.2379 | .0392 | -.0097 | .0052 |
| 17 | 0 | 0 | 0 | .0094 | -.0086 |
| 18 | .12673 | -.0791 | -.0767 | -.0031 | -.3001 |
| 19 | 0 | .0999 | 0 | .0197 | .2707 |
| 20 | .09628 | -.0872 | 0 | -.0029 | -.1031 |
| 21 | -.14168 | .0655 | .1031 | .0048 | .1710 |
| 22 | 0 | .1285 | .0172 | -.0007 | -.0230 |
| 23 | 0 | -.0981 | 0 | .0007 | -.0013 |
| Intercept | 1.55902 | 14.6679 | -16.8662 | .1509 | .9509 |
| $R^2$ | .3091 | .5685 | .2209 | .6384 | .71910 |

Table 33. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 9

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.1086 | .3182 | -.0136 | .0024 | 0 |
| 25 | .1251 | -.0461 | .2556 | -.0009 | .2429 |
| 26 | -.2066 | .4209 | .1189 | .0018 | .2551 |
| 27 | .0969 | -.7085 | -.1713 | -.0013 | -.2545 |
| 28 | .0499 | .0058 | .441 | 0 | -.1849 |
| 29 | .1272 | .1047 | -.3040 | -.0023 | .1367 |
| 30 | -.0712 | -.8083 | -.0979 | .0023 | .1652 |
| 31 | -.1370 | -.2769 | -.1962 | .0008 | 0 |
| 32 | .0903 | .6554 | -.1894 | -.0015 | .3702 |
| Intercept | 3.5015 | 24.1530 | 15.7679 | .3412 | -3.8197 |
| $R^2$ | .8354 | .9063 | .9006 | .5271 | .4761 |

Table 34. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 10

| Standard weeks | MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| | Regression coefficients for the weather parameters | | | | |
| 15 | .33526 | -.1856 | -.1997 | -.252 | -.1856 |
| 16 | -.37548 | -.2905 | -.0414 | .0085 | -.0753 |
| 17 | .08617 | -.0636 | .0319 | .0235 | .0912 |
| 18 | .06393 | -.2290 | -.0396 | -.0008 | -.0407 |
| 19 | .13224 | .2761 | -.0438 | .0099 | -.0937 |
| 20 | -.06058 | -.0781 | .2512 | .0041 | .0935 |
| 21 | -.16466 | -.0819 | -.0182 | .0072 | .2009 |
| 22 | .00713 | .1476 | .0335 | -.0029 | -.1732 |
| 23 | .01280 | .0284 | .0340 | .0009 | -.0846 |
| Intercept | -2.38950 | 28.03199 | .173 | .8775 | 2.1786 |
| $R^2$ | .952576 | .86862 | .5806 | .7225 | .5852 |

Table 35. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 10

| Standard weeks | MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| | Regression coefficients for the weather parameters | | | | |
| 24 | .0228 | .2793 | .1230 | .0007 | -.0915 |
| 25 | 0 | .2329 | .1283 | -.0022 | .1193 |
| 26 | 0 | -.0283 | -.4462 | .0022 | .3455 |
| 27 | 0 | -.3873 | .0862 | -.0009 | 0 |
| 28 | 0 | -.2681 | -.6704 | 0 | -.1673 |
| 29 | -.1062 | -.0406 | .1936 | -.0007 | .4485 |
| 30 | .0487 | -.7903 | .1324 | .0022 | .0618 |
| 31 | 0 | -.1808 | .2311 | .0016 | 0 |
| 32 | .0476 | .5873 | .1289 | -.0020 | .2192 |
| Intercept | .3218 | 44.281 | 11.1748 | 1.3045 | -4.3375 |
| $R^2$ | .2480 | .5883 | .7500 | .5213 | .5868 |

Table 36. Estimated first stage regression models from weekly weather parameters of group I for the variety 11 - Karimunda-2

| Standard weeks | MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| | Regression coefficient for the weather parameters | | | | |
| 15 | -.0574 | -.1782 | -.0197 | .0150 | .5120 |
| 16 | .5002 | .1048 | .0608 | 0 | -.0387 |
| 17 | 0 | -.0648 | -.0433 | -.0172 | -.0616 |
| 18 | .01711 | .0534 | -.1235 | 0 | -.3210 |
| 19 | -.0497 | -.1815 | -.1230 | 0 | .2771 |
| 20 | .0641 | -.1622 | .1622 | .0046 | .1367 |
| 21 | -.3765 | .2767 | .1293 | -.0044 | -.1889 |
| 22 | .0436 | -.1805 | .0414 | 0 | -.2468 |
| 23 | .1263 | .2003 | -.0649 | .0020 | .2373 |
| Intercept | -24.4455 | 11.5457 | -.3698 | 1.1399 | 1.0994 |
| $R^2$ | .6448 | .8409 | .69556 | .31923 | .6368 |

Table 37. Estimated first stage regression models from weekly weather parameters of group II for the variety 11 - Karimunda-2

| Standard weeks | MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| | Regression coefficient for the weather parameters | | | | |
| 24 | -.0853 | .1590 | .0220 | .0014 | 0 |
| 25 | .2221 | .1384 | .0343 | -.0023 | -.1086 |
| 26 | -.2104 | .4684 | -.0845 | .0005 | .3794 |
| 27 | .1140 | -.4985 | -.1879 | -.0004 | -.1538 |
| 28 | -.1105 | -.1456 | .5350 | .0026 | .5973 |
| 29 | 0 | -.3101 | -.2818 | -.0014 | .5162 |
| 30 | -.0130 | 0 | .1022 | 0 | 0 |
| 31 | 0 | .1831 | -.2686 | -.0017 | -.1947 |
| 32 | 0 | .10 | -.3485 | -.0031 | 0 |
| Intercept | 8.5007 | 1.6376 | 47.1992 | 2.2636 | -5.1585 |
| $R^2$ | .3588 | .4775 | .5889 | .5213 | .3844 |

Table 38. Estimated first stage regression models from weekly weather parameters of group I for the variety 12 - Karimunda-3

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .056 | .0573 | -.0155 | -.0123 | .0751 |
| 16 | -.0857 | -.0139 | -.0131 | -.0035 | -.0108 |
| 17 | .0007 | -.0457 | -.0290 | .0163 | .0910 |
| 18 | .0305 | .1511 | .0298 | -.0004 | -.1465 |
| 19 | .0490 | -.0514 | -.0050 | .0129 | .1568 |
| 20 | -.0125 | -.0261 | .0543 | -.0010 | 0 |
| 21 | .0260 | -.0894 | -.0331 | .0007 | -.1804 |
| 22 | .0115 | .0824 | -.0218 | -.0022 | -.0644 |
| 23 | .0143 | .1203 | -.0249 | .0002 | .0153 |
| Intercept | -7.61339 | -13.0912 | 5.8691 | .5392 | 1.0577 |
| $R^2$ | .75864 | .7174 | .58370 | .73274 | .5155 |

Table 39. Estimated first stage regression models from weekly weather parameters of group II for the variety 12 - Karimunda-3

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | .0130 | .045 | -.0293 | 0 | 0 |
| 25 | .0511 | .7018 | .1274 | 0 | .0611 |
| 26 | -.0261 | .4173 | -.1465 | .0004 | .1207 |
| 27 | .0623 | .59910 | .0261 | 0 | 0 |
| 28 | -.0335 | .1221 | -.0202 | 0 | -.2401 |
| 29 | -.0443 | .6947 | -.0221 | 0 | -.1332 |
| 30 | .0445 | 1.02694 | -.0451 | 0 | .0780 |
| 31 | -.0179 | .2458 | .0678 | .0008 | .0579 |
| 32 | .0237 | .1016 | -.0065 | 0 | .1924 |
| Intercept | -5.4650 | 46.6654 | 5.5025 | .44933 | -.0335 |
| $R^2$ | .6178 | .640 | .7465 | .1116 | .4886 |

Table 40. Estimated first stage regression models from weekly weather parameters of group I for the variety 13 - Karivally

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | -.0097 | -.2329 | 0 | -.0098 | .0456 |
| 16 | -.0832 | .1077 | 0 | -.0073 | .0216 |
| 17 | -.0814 | -.0725 | .0769 | 0 | .3152 |
| 18 | .0434 | -.0021 | -.1521 | -.0035 | -.8009 |
| 19 | .2685 | -.0505 | -.0306 | .0129 | .6920 |
| 20 | .1385 | .0499 | 0 | 0 | -.1625 |
| 21 | -.1693 | .0415 | .0655 | -.0011 | -.278 |
| 22 | .0440 | .1449 | .0436 | -.0019 | -.3604 |
| 23 | -.0132 | -.0227 | 0 | .0043 | .2944 |
| Intercept | -11.6205 | -3.6976 | 1.2392 | .9154 | 1.8673 |
| $R^2$ | .65125 | .8154 | .3192 | .46104 | .7396 |

Table 41. Estimated first stage regression models from weekly weather parameters of group II for the variety 13 - Karivally

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.1928 | .1834 | -.1554 | .0026 | .2007 |
| 25 | .2689 | .3912 | .2954 | -.0012 | -.1058 |
| 26 | -.3066 | .3538 | .3261 | .0001 | .4594 |
| 27 | .1403 | -.8195 | -.1647 | -.0001 | -.8558 |
| 28 | .0709 | -.0373 | .8524 | .001 | .5663 |
| 29 | .0950 | .2443 | -.3538 | -.0045 | -.3413 |
| 30 | -.0658 | -1.2481 | -.3689 | .0028 | .1537 |
| 31 | -.1068 | -.2646 | -.3004 | -.0020 | -.4892 |
| 32 | .0594 | .7092 | -.4664 | -.0049 | .1430 |
| Intercept | 4.9051 | 36.2884 | 33.3862 | 2.5124 | 3.2715 |
| $R^2$ | .6432 | .8464 | .9722 | .6209 | .5991 |

Table 42. Estimated first stage regression models from weekly weather parameters of group I for variety 14 - Kottanadan

| Standard weeks | MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| | Regression coefficient for the weather parameters | | | | |
| 15 | .3062 | .0273 | -.1020 | -.0187 | -.5999 |
| 16 | -.2605 | -.2309 | .0673 | .0409 | .2561 |
| 17 | .0848 | -.0627 | -.0920 | .0068 | .0247 |
| 18 | .2084 | .2572 | 0 | -.0037 | -.2105 |
| 19 | -.2579 | -.1802 | -.0031 | .0122 | .1541 |
| 20 | .0843 | .0042 | .0664 | .0018 | -.2056 |
| 21 | -.0702 | -.1761 | .0687 | -.0023 | .3473 |
| 22 | -.0341 | .1965 | -.0457 | -.0009 | -.2671 |
| 23 | .0104 | -.0529 | .04998 | .0046 | .0437 |
| Intercept | -5.6334 | 18.1009 | .10833 | .3148 | 2.1166 |
| $R^2$ | .59136 | .86103 | .5329 | .76038 | .8538 |

Table 43. Estimated first stage regression models from weekly weather parameters of group II for the variety 14 - Kottanadan

| Standard weeks | MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| | Regression coefficient for the weather parameters | | | | |
| 24 | 0 | .3030 | .0447 | .0022 | 0 |
| 25 | -.1010 | .4336 | .1167 | -.0027 | .0985 |
| 26 | 0 | .1832 | .3406 | .0015 | -.0947 |
| 27 | 0 | -.4670 | -.0469 | -.0013 | -.3176 |
| 28 | .3500 | -.4440 | .2671 | .0006 | 0 |
| 29 | .1571 | -.0453 | -.2008 | -.001 | .1166 |
| 30 | 0 | -.6696 | -.1468 | .0004 | .0629 |
| 31 | -.2551 | -.1593 | -.1621 | .0018 | .0640 |
| 32 | 0 | .5361 | -.2260 | -.0026 | 0 |
| Intercept | -11.0076 | 24.7946 | 2.7122 | 1.7891 | 2.1100 |
| $R^2$ | .2200 | .5776 | .7106 | .5852 | .3894 |

Table 44. Estimated first stage regression models from weekly weather parameters of group I for the variety 15 - Kumbhakody

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .5093 | -.4324 | -.0997 | -.0421 | -.5724 |
| 16 | -1.2777 | -.1614 | .0056 | .0410 | -.5584 |
| 17 | .0378 | -.0625 | .1281 | .0561 | .5670 |
| 18 | .1414 | .0370 | .0050 | -.001 | -.6868 |
| 19 | .1920 | .0132 | .0366 | .0334 | .5077 |
| 20 | .1186 | .1814 | -.0253 | -.009 | -.6132 |
| 21 | -.0209 | -.7004 | -.1345 | .0076 | .4869 |
| 22 | .2672 | .8088 | -.1944 | -.0109 | -.7880 |
| 23 | -.3871 | -.5885 | .2974 | .0095 | .0602 |
| Intercept | 41.8620 | 47.6113 | .0975 | .1637 | 5.3036 |
| $R^2$ | .9006 | .8482 | .67733 | .6675 | .5991 |

Table 45. Estimated first stage regression models from weekly weather parameters of group II for the variety 15 - Kumbhakody

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.1679 | .2349 | -.1712 | .0023 | .3806 |
| 25 | .2280 | .4865 | .2410 | -.0020 | -.6685 |
| 26 | -.2043 | 1.1091 | .8364 | -.0029 | .4381 |
| 27 | .1482 | -3.2377 | -.3383 | .0010 | -.0811 |
| 28 | 0 | .400 | .1172 | -.0040 | -2.3731 |
| 29 | -.0138 | .0568 | .0428 | -.0031 | -1.4373 |
| 30 | 0 | -1.3796 | -.8050 | .0007 | -.1721 |
| 31 | .0126 | -.5469 | .1142 | .0037 | .4462 |
| 32 | .0818 | .6616 | -.2268 | -.0162 | .3285 |
| Intercept | -5.2978 | 162.0319 | 19.8636 | 6.1490 | 22.4123 |
| $R^2$ | .4692 | .8226 | .8538 | .6956 | .6922 |

Table 46. Estimated first stage regression models from weekly weather parameters of group I for the variety 16 Kuthiravally

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .6050 | -.0635 | .0367 | -.0289 | -.2781 |
| 16 | -.3835 | -.9490 | .1144 | .0250 | .1430 |
| 17 | .0279 | .1340 | -.2044 | .0073 | .0875 |
| 18 | .1721 | -.7926 | -.1652 | -.0007 | -.1593 |
| 19 | -.0123 | .5439 | .0591 | .0205 | .3143 |
| 20 | -.0075 | -.3053 | .1286 | .0148 | .1912 |
| 21 | -.4180 | .0420 | .3366 | .0062 | .1843 |
| 22 | -.0091 | .3416 | -.1813 | -.0018 | -.2615 |
| 23 | .0792 | -.1107 | -.0898 | .0026 | -.0317 |
| Intercept | -4.6106 | 90.0661 | -1.6686 | -.2456 | 1.3553 |
| $R^2$ | .7921 | .89492 | .79388 | .6996 | .6197 |

Table 47. Estimated first stage regression models from weekly weather parameters of group II for the variety 16 - Kuthiravally

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0827 | .9077 | .1500 | .0006 | -.2674 |
| 25 | .36610 | .4026 | .2578 | -.0057 | .5084 |
| 26 | -.4720 | .1790 | -.0305 | .0069 | .2178 |
| 27 | .1945 | -.6674 | .0936 | -.0031 | .8130 |
| 28 | -.1268 | -.1784 | -.1038 | .0032 | 0 |
| 29 | -.2209 | -.2740 | -.3191 | -.0015 | .8162 |
| 30 | .0467 | -1.4759 | 0 | .001 | .1879 |
| 31 | .0571 | -.5377 | .0259 | .0008 | .1659 |
| 32 | .1347 | 1.8289 | -.1248 | -.0043 | -.1965 |
| Intercept | 9.9823 | -13.5341 | 6.7442 | 1.8323 | -13.0117 |
| $R^2$ | .7957 | .8100 | .5155 | .8949 | .5198 |

Table 48. Estimated first stage regression models from weekly weather parameters of group I for the variety 17 - Kuthiravally-AR

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | -.1035 | -.3970 | -.3341 | .0399 | 0 |
| 16 | -.7114 | .1185 | -.2076 | -.0063 | -.1132 |
| 17 | -.0872 | .1609 | .1894 | .0545 | .5529 |
| 18 | .1762 | .2440 | .1298 | -.0101 | -.284 |
| 19 | .4645 | .1663 | .1429 | .0325 | .2679 |
| 20 | -.0839 | -.1024 | .0803 | -.0064 | -.22388 |
| 21 | .4180 | -.5204 | -.2898 | .0121 | .0563 |
| 22 | .0109 | .3561 | .0591 | -.0087 | -.3656 |
| 23 | -.0779 | .0410 | -.0035 | -.0002 | -.1355 |
| Intercept | 2.8242 | -2.9830 | 22.4742 | 1.7795 | 3.2908 |
| $R^2$ | .7885 | .7345 | .83357 | .6757 | .5446 |

Table 49. Estimated first stage regression models from weekly weather parameters of group II for the variety 17 - Kuthiravally-AR

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | .1670 | -.0927 | -.1528 | .0003 | -.3515 |
| 25 | .0725 | 1.0024 | 1.1659 | -.0012 | .0084 |
| 26 | 0 | -1.5004 | -.3535 | .0027 | .2724 |
| 27 | -.3052 | 1.1063 | .3672 | .0027 | -1.2103 |
| 28 | .3417 | -.4097 | -1.0861 | -.0032 | .4072 |
| 29 | .2743 | 1.1267 | .4197 | -.0039 | -.4814 |
| 30 | .2572 | -1.0019 | -.1582 | .0049 | .0105 |
| 31 | -.0061 | .0004 | .6158 | .0019 | -.4879 |
| 32 | .14787 | -.2099 | .4364 | .0024 | .4448 |
| Intercept | -10.5138 | .5832 | -22.7442 | .3318 | 10.4586 |
| $R^2$ | .5670 | .7242 | .8668 | .7006 | .6147 |

Table 50. Estimated first stage regression models from weekly weather parameters of group I for the variety 18 - Munda

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | -.0398 | 0 | .0986 | -.0060 | .5225 |
| 16 | .0601 | -.0564 | -.0610 | .0172 | .0466 |
| 17 | -.0424 | -.0367 | -.0041 | .0083 | .1971 |
| 18 | -.0219 | -.0589 | -.0061 | -.0001 | -.2083 |
| 19 | .0845 | 0 | -.0398 | .0034 | .1581 |
| 20 | .0480 | -.0479 | .0377 | .0026 | .0679 |
| 21 | -.1206 | 0 | .0179 | .0008 | -.2790 |
| 22 | .0453 | 0 | -.0602 | -.0023 | -.1601 |
| 23 | .0751 | .1106 | -.039 | .0004 | .0261 |
| Intercept | -7.1134 | 7.7966 | 5.9334 | .7900 | .9678 |
| $R^2$ | .7191 | .32376 | .91394 | .6273 | .8630 |

Table 51. Estimated first stage regression models from weekly weather parameters of group II for the variety 18 - Munda

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | .0106 | 0 | -.0524 | -.0012 | 0 |
| 25 | 0 | 0 | .0761 | -.001 | -.1819 |
| 26 | 0 | -.0419 | 0 | 0 | .1815 |
| 27 | .0986 | 0 | .0629 | 0 | .2144 |
| 28 | -.1334 | 0 | 0 | .0009 | 0 |
| 29 | -.1355 | 0 | .0371 | .0005 | -.1752 |
| 30 | .1419 | 0 | -.1628 | -.0004 | .0483 |
| 31 | .0605 | .0551 | .130 | .0004 | -.0579 |
| 32 | .0527 | 0 | -.0223 | .0031 | -.1178 |
| Intercept | -7.2335 | -.1341 | -5.9189 | 1.4579 | 1.1763 |
| $R^2$ | .4330 | .07 | .4583 | .4597 | .4665 |

Table 52. Estimated first stage regression models from weekly weather parameters of group I for the variety 19 - Narayakodi

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .5791 | -.3128 | 0 | -.0348 | -.6089 |
| 16 | -.0162 | -.6773 | .0125 | -.0013 | -.1512 |
| 17 | -.0210 | .1126 | 0 | .0176 | .3517 |
| 18 | .2314 | -.5756 | -.2027 | -.0006 | -.4074 |
| 19 | .3077 | .5681 | .0878 | .0267 | .5569 |
| 20 | .0397 | -.2234 | -.0502 | .0057 | -.1999 |
| 21 | -.2321 | -.0207 | .2264 | .0173 | .4027 |
| 22 | -.0159 | .4104 | -.0438 | -.0033 | -.3512 |
| 23 | -.1495 | -.5040 | .0172 | .0051 | .1036 |
| Intercept | 17.8029 | 95.2335 | -2.1093 | .1122 | 2.2475 |
| $R^2$ | .8427 | .69389 | .4422 | .6416 | .7293 |

Table 53. Estimated first stage regression models from weekly weather parameters of group II for the variety 19 - Narayakodi

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.1006 | .3907 | -.0849 | .0028 | -.1797 |
| 25 | .2250 | .9268 | .3192 | -.0048 | .1423 |
| 26 | -.4220 | -.3670 | .2706 | .0056 | .3386 |
| 27 | .0284 | -.2036 | -.1197 | -.0016 | -.6016 |
| 28 | .3643 | .2191 | .1001 | -.0012 | .4303 |
| 29 | .2285 | .4229 | -.1919 | -.0055 | .2174 |
| 30 | -.2343 | -2.0939 | -.2178 | .0059 | .1033 |
| 31 | -.1105 | -.6903 | -.1769 | -.0015 | -.6168 |
| 32 | .0448 | 2.0104 | -.0753 | -.0043 | 0 |
| Intercept | .2849 | -43.6367 | 19.0201 | 3.1318 | 2.9500 |
| $R^2$ | .7621 | .7815 | .9006 | .8354 | .5256 |

Table 54. Estimated first stage regression models from weekly weather parameter of group I for the variety 20 - Palulauta

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .0957 | -.1747 | -.0895 | -.0142 | -.1956 |
| 16 | -.3579 | .0205 | -.0160 | .0133 | .0127 |
| 17 | -.0420 | -.0753 | .0488 | .0251 | .3052 |
| 18 | -.0685 | -.0996 | .0163 | -.0029 | -.2896 |
| 19 | .2408 | .1095 | -.0195 | .0071 | .2089 |
| 20 | .0932 | .2579 | 0 | -.0049 | -.2446 |
| 21 | .0110 | -.2112 | .0358 | 0 | -.0003 |
| 22 | .0166 | .1668 | -.0262 | -.0023 | -.2515 |
| 23 | -.0256 | .0239 | -.0094 | .0008 | .0235 |
| Intercept | 4.61716 | -.6741 | 5.8913 | .5141 | 1.6804 |
| $R^2$ | .8281 | .7921 | .52273 | .5565 | .9025 |

Table 55. Estimated first stage regression models from weekly weather parameters of group II for the variety 20 - Palulauta

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0603 | .0254 | -.0238 | .0007 | .1379 |
| 25 | 0 | .1729 | .0635 | 0 | -.1464 |
| 26 | 0 | .0907 | .1294 | 0 | .0617 |
| 27 | -.0819 | -.7611 | .1663 | .001 | -.0066 |
| 28 | .1422 | -.1069 | -.1204 | -.0008 | 0 |
| 29 | .0098 | .0873 | .0578 | 0 | -.3979 |
| 30 | -.0610 | -.7377 | -.1533 | .0015 | .0945 |
| 31 | -.0375 | .0049 | .0280 | 0 | -.1321 |
| 32 | .0539 | .1135 | -.0923 | -.0018 | -.2186 |
| Intercept | 3.6895 | 81.1477 | -4.2704 | .3012 | 4.4212 |
| $R^2$ | .4356 | .8836 | .8208 | .2916 | .5170 |

Table 56. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 21 - Perumkodi

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .1400 | -.36695 | -.0110 | -.0079 | .0668 |
| 16 | -.2918 | -.5876 | -.0045 | -.0062 | .0242 |
| 17 | -.0817 | .2021 | .0081 | -.0065 | .3357 |
| 18 | .0871 | -.7346 | -.2044 | -.0008 | -.3658 |
| 19 | .3501 | .6701 | .1209 | .0029 | .4629 |
| 20 | -.0514 | -.1678 | -.0519 | .0105 | .0578 |
| 21 | -.1299 | -.0447 | .1234 | .008 | -.0617 |
| 22 | .0043 | .3325 | .0182 | -.0015 | -.3303 |
| 23 | -.0308 | -.3247 | -.0728 | .0025 | .1660 |
| Intercept | 1.0941 | 78.6802 | 8.0554 | .2586 | .6687 |
| $R^2$ | .7362 | .6956 | .83174 | .6642 | .6906 |

Table 57. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 21 - Perumkodi

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | .0323 | .2318 | -.0792 | -.0003 | -.0803 |
| 25 | .1629 | .9974 | .0937 | -.0032 | 0 |
| 26 | -.2765 | -.8533 | 0 | .0040 | .2192 |
| 27 | -.0404 | .8828 | .0896 | -.0004 | 0 |
| 28 | .1872 | -.1004 | -.2939 | .0005 | 0 |
| 29 | .0906 | .2670 | .0262 | -.0041 | 0 |
| 30 | -.2192 | -1.5016 | .0293 | .0041 | .095 |
| 31 | .0358 | -.4235 | .0496 | -.0027 | -.1179 |
| 32 | -.0383 | 1.6626 | .0089 | -.0033 | -.1254 |
| Intercept | 6.4613 | -83.9233 | 8.2688 | 2.0208 | .9299 |
| $R^2$ | .6384 | .7534 | .5285 | .8482 | .2959 |

Table 58. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 22 - Perumunda

| Standard weeks | Regression coefficient for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .5170 | -.3543 | -.1504 | -.0477 | -.6099 |
| 16 | -1.1569 | -.5737 | -.1263 | .0041 | -.3820 |
| 17 | .0047 | .2001 | .1677 | .0228 | .2794 |
| 18 | .2332 | -.6619 | -.0375 | -.0009 | .0754 |
| 19 | .2802 | .6381 | .1251 | .0193 | -.0547 |
| 20 | .0373 | -.1372 | 0 | .0026 | -.2543 |
| 21 | -.1156 | -.2321 | -.0574 | -.0574 | .7474 |
| 22 | -.0082 | .4076 | .0144 | -.0056 | -.1980 |
| 23 | -.1515 | -.5282 | .1148 | .0022 | -.2664 |
| Intercept | 35.4539 | 95.8127 | -3.1392 | .3479 | 2.8527 |
| $R^2$ | .8208 | .71403 | .5198 | .6889 | .6939 |

Table 59. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 22 - Perumunda

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0341 | .1144 | -.0410 | .0016 | -.2893 |
| 25 | -.0209 | .430 | .1862 | -.0015 | .0426 |
| 26 | -.1760 | -.6072 | -.227 | .0030 | .3511 |
| 27 | -.1259 | .0038 | -.0404 | -.0004 | -.5508 |
| 28 | .4412 | .0825 | -.9071 | -.0050 | -.1682 |
| 29 | .1776 | .4813 | .3917 | -.0007 | .1319 |
| 30 | -.1352 | -1.1856 | -.1531 | .0042 | -.0628 |
| 31 | -.0893 | -.4746 | .3446 | .0039 | -.4347 |
| 32 | .0858 | 1.0168 | .4464 | -.0048 | .1707 |
| Intercept | -8.6433 | 11.1469 | -17.8730 | 1.4850 | 6.5247 |
| $R^2$ | .7310 | .7123 | .9197 | .8724 | .5730 |

Table 60. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 23 - Sallia

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .2215 | -.1934 | -.0180 | -.0268 | -.3811 |
| 16 | -.6207 | -.4595 | -.0922 | .0143 | .0027 |
| 17 | -.0278 | .1200 | .1200 | .0150 | .2100 |
| 18 | .1933 | -.4241 | -.0955 | -.0051 | -.2434 |
| 19 | .1945 | .4004 | .03411 | .0176 | .1807 |
| 20 | .0719 | -.2420 | .0212 | .0014 | -.1025 |
| 21 | -.1250 | .0056 | .0728 | .0129 | .4358 |
| 22 | -.0212 | .2588 | 0 | -.0022 | -.1502 |
| 23 | -.0599 | -.3863 | .0617 | .0020 | -.0995 |
| Intercept | 17.5357 | 70.9126 | -17.3883 | .1145 | 1.5104 |
| $R^2$ | .7850 | .5806 | .50268 | .6956 | .8630 |

Table 61. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 23 - Sallia

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0614 | .1693 | -.0560 | .0018 | -.1036 |
| 25 | .1113 | .6150 | .2462 | -.0021 | 0 |
| 26 | -.2320 | -.4869 | .2381 | .0020 | .3461 |
| 27 | -.0290 | .3380 | -.0559 | -.0008 | -.6251 |
| 28 | .1828 | -.0956 | .059 | -.0014 | 0 |
| 29 | .2241 | .5679 | -.091 | -.0026 | 0 |
| 30 | -.1355 | -1.2484 | -.2953 | .0039 | .0638 |
| 31 | -.0681 | -.4847 | .0287 | .0018 | -.2615 |
| 32 | .0134 | 1.2224 | .0308 | -.0040 | .3354 |
| Intercept | .6640 | -42.8281 | -9.0408 | 1.4211 | 2.7286 |
| $R^2$ | .7259 | .8612 | .7208 | .6773 | .3782 |

Table 62. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 24 - Taliparamba 1

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .1565 | -.4771 | -.3499 | -.0301 | -.2717 |
| 16 | -.6911 | .4700 | -.0707 | -.0110 | -.5361 |
| 17 | -.0712 | -.0243 | .1842 | .0430 | .4122 |
| 18 | .0790 | .1480 | .0531 | -.0049 | -.2507 |
| 19 | .4056 | -.0655 | .0571 | .0295 | .2994 |
| 20 | .0338 | -.0068 | .1221 | -.0068 | -.3488 |
| 21 | .0068 | -.3662 | -.1081 | .0117 | .3775 |
| 22 | .1122 | .2769 | -.0187 | -.0082 | -.4632 |
| 23 | -.1678 | .0072 | .0626 | .0026 | -.0694 |
| Intercept | 14.7396 | 5.89462 | 7.3483 | 1.0028 | 3.4352 |
| $R^2$ | .8208 | .75689 | .67898 | .9409 | .8761 |

Table 63. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 24 - Taliparamba 1

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0627 | .0450 | -.0702 | .0035 | -.1607 |
| 25 | .1844 | .7018 | .1419 | -.0014 | -.0861 |
| 26 | .1861 | .4173 | -.0625 | .0023 | .4227 |
| 27 | -.2043 | -.5991 | .0806 | .0026 | -.5898 |
| 28 | .3729 | .1221 | -.5104 | -.0039 | -.0331 |
| 29 | .1675 | .6947 | .1240 | -.0035 | -.3478 |
| 30 | -.1095 | 1.0269 | -.2535 | .0039 | -.1380 |
| 31 | -.1075 | .2458 | .2694 | .0016 | -.3705 |
| 32 | -.0049 | .1016 | .1281 | -.0017 | .2442 |
| Intercept | -2.7678 | 46.6654 | 16.2356 | .6520 | 8.0938 |
| $R^2$ | .801 | .8761 | .9082 | .8482 | .6162 |

Table 64. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 25 - Taliparamba II

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .1066 | -.1370 | -.051 | -.0037 | 0 |
| 16 | -.0443 | -.1219 | .0393 | .0106 | .1075 |
| 17 | -.0118 | -.0341 | -.0111 | 0 | 0 |
| 18 | -.0256 | -.2230 | -.0488 | -.0021 | -.1081 |
| 19 | .0474 | .1023 | -.0396 | 0 | 0 |
| 20 | .1098 | .1437 | .0280 | 0 | 0 |
| 21 | -.1811 | .0142 | .1304 | 0 | 0 |
| 22 | -.0199 | .0102 | 0 | 0 | -.0809 |
| 23 | .0717 | .0605 | -.0449 | 0 | 0 |
| Intercept | 4.5249 | 14.5952 | .1853 | .4306 | .7289 |
| $R^2$ | .5960 | .9448 | .52273 | .1568 | .1806 |

Table 65. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 25 - Taliparamba II

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.156 | .1342 | .0530 | .0011 | .0408 |
| 25 | .1817 | .1511 | .01291 | .0002 | -.0155 |
| 26 | -.1903 | .1462 | .0932 | .0001 | .0583 |
| 27 | .0316 | .3946 | .0713 | .0001 | .0403 |
| 28 | -.0004 | -.2631 | .0567 | .0003 | .5087 |
| 29 | -.0710 | -.1488 | -.0659 | .0009 | .1876 |
| 30 | -.0627 | -.5501 | .0145 | .0007 | .0856 |
| 31 | .0545 | 0 | -.1062 | .0008 | -.1902 |
| 32 | .0965 | .4026 | -.1678 | -.0028 | -.3411 |
| Intercept | 10.4501 | 38.0500 | 4.1151 | -.1057 | -2.0830 |
| $R^2$ | .8649 | .5685 | .6464 | .8372 | .7157 |

Table 66. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 26 - Thaliparamba III

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .5150 | -.3402 | -.1127 | -.0328 | -.711 |
| 16 | -.7857 | -.7541 | .0146 | -.0126 | -.0660 |
| 17 | -.0183 | .2185 | .0444 | -.0051 | .2104 |
| 18 | .2486 | -.7504 | -.2216 | -.001 | -.2851 |
| 19 | .2429 | .7239 | .1365 | .0149 | .3835 |
| 20 | .0472 | -.1197 | -.0266 | .0079 | -.1574 |
| 21 | -.2353 | .0164 | .1418 | .0191 | .4273 |
| 22 | -.0711 | .3405 | .0716 | -.0015 | -.2357 |
| 23 | -.0783 | -.4660 | .0121 | .0037 | .0513 |
| Intercept | 12.8979 | 86.83067 | -4.3373 | -.1962 | 1.1814 |
| $R^2$ | .82992 | .59908 | .5746 | .6241 | .6068 |

Table 67. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 26 - Taliparamba III

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.1184 | .3712 | -.0456 | .0027 | -.2378 |
| 25 | .2123 | .6223 | .2562 | -.0031 | .3379 |
| 26 | -.4296 | -.4275 | .1282 | .0054 | .3242 |
| 27 | .0173 | .2547 | -.1059 | -.0021 | -.8386 |
| 28 | .3591 | -.0284 | -.1459 | -.0014 | .7481 |
| 29 | .1880 | .2602 | -.0491 | -.0038 | .5498 |
| 30 | -.2816 | -1.7449 | -.0331 | .0052 | .1253 |
| 31 | -.0932 | -.6655 | -.1086 | -.0004 | -.6567 |
| 32 | .0806 | 1.8923 | .0189 | -.0036 | .0109 |
| Intercept | 6.8057 | -38.7201 | 9.3167 | 1.3374 | -1.3527 |
| $R^2$ | .8987 | .6906 | .8336 | .9273 | .7797 |

Table 68. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 27 - Taliparamba IV

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .0932 | -.0933 | .0172 | -.0220 | .0830 |
| 16 | -.3341 | -.2952 | -.1291 | .0234 | -.0237 |
| 17 | -.02799 | .0595 | .1106 | .0151 | .1922 |
| 18 | .0963 | -.3606 | -.0193 | -.0029 | -.0999 |
| 19 | .1095 | .2668 | -.0122 | .0102 | .0015 |
| 20 | .0746 | -.2001 | .0750 | .0018 | -.0048 |
| 21 | -.1401 | 0 | -.0116 | .0095 | .2100 |
| 22 | .0250 | .1598 | -.0355 | -.0028 | -.1112 |
| 23 | 0 | -.2356 | .0665 | .0011 | -.1386 |
| Intercept | 10.6974 | 53.6424 | -5.0379 | -.1272 | 1.0003 |
| $R^2$ | .5506 | .55652 | .7157 | .6053 | .7310 |

Table 69. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 27 - Taliparamba IV

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0323 | .0735 | -.0420 | .0002 | -.0785 |
| 25 | .0382 | .2570 | .1653 | -.0010 | -.0741 |
| 26 | -.0989 | -.2595 | .1291 | 0 | .2345 |
| 27 | .0119 | .0387 | .0013 | -.0003 | 0 |
| 28 | .0267 | -.0713 | -.0557 | -.0011 | 0 |
| 29 | .0327 | .3533 | .0495 | .0001 | 0 |
| 30 | .0577 | -.5525 | -.3319 | .001 | 0 |
| 31 | .0039 | -.2273 | .1816 | .0026 | -.1353 |
| 32 | .0277 | .4801 | .1017 | -.0045 | 0 |
| Intercept | -5.1245 | -6.3831 | -18.6850 | 1.1098 | .7532 |
| $R^2$ | .5898 | .7656 | .7362 | .5373 | .247 |

Table 70. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 28 - Valli

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .2145 | .0070 | .0555 | -.0238 | -.3151 |
| 16 | -.5790 | -.0849 | 0 | 0 | .0288 |
| 17 | -.0475 | -.1378 | 0 | .0389 | .4178 |
| 18 | -.0233 | -.0044 | 0 | -.0012 | -.4857 |
| 19 | .2943 | .1217 | 0 | .0211 | .4809 |
| 20 | .0631 | .1532 | -.0843 | -.0064 | -.2560 |
| 21 | .0892 | -.2068 | .0645 | .0002 | -.1495 |
| 22 | .0322 | .3243 | -.1051 | -.0027 | -.2106 |
| 23 | -.1398 | -.1753 | .0317 | .0024 | .1256 |
| Intercept | 10.5153 | 1.3816 | 4.7118 | .5975 | 1.9137 |
| $R^2$ | .73103 | .71234 | .33408 | .5314 | .7621 |

Table 71. Estimated 1ststage regression models from weekly weather parameters of group II for the variety 28 - Valli

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | -.0341 | .0892 | -.1306 | 0 | .2717 |
| 25 | -.0095 | .1073 | .2618 | 0 | -.1014 |
| 26 | -.0387 | .3465 | .3755 | -.0012 | .0814 |
| 27 | 0 | -1.1899 | .0495 | 0 | -.0800 |
| 28 | .1945 | .3157 | .4237 | 0 | -.6325 |
| 29 | .0823 | .2580 | -.1729 | -.0015 | -.8241 |
| 30 | 0 | -1.0375 | -.4536 | 0 | .1551 |
| 31 | -.1610 | -.2285 | -.1337 | 0 | -.0179 |
| 32 | 0 | .3480 | -.2140 | -.0045 | .1273 |
| Intercept | -1.3886 | 72.9140 | .3008 | 2.6368 | 7.9758 |
| $R^2$ | .3770 | .8010 | .7691 | .1866 | .7850 |

Table 72. Estimated 1st stage regression models from weekly weather parameters of group I for the variety 29 - Valiyakodi

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 15 | .2267 | .1195 | .3455 | -.0045 | .1953 |
| 16 | .0783 | -1.2093 | .0014 | .0545 | .6578 |
| 17 | 0 | .1967 | -.1819 | -.0100 | .0663 |
| 18 | .1325 | -.9575 | -.2212 | -.0033 | -.1643 |
| 19 | -.0954 | .6715 | -.0075 | .0012 | .1990 |
| 20 | -.0136 | -.5262 | .0221 | .0181 | .4544 |
| 21 | -.3452 | .3667 | .4207 | -.0026 | -.0181 |
| 22 | -.0723 | .1612 | -.1734 | .0037 | -.0134 |
| 23 | .1633 | -.3213 | -.1038 | .0012 | .0053 |
| Intercept | -6.0351 | 115.7641 | -7.2209 | -.0262 | -.2773 |
| $R^2$ | .51696 | .91203 | .91585 | .8281 | .8317 |

Table 73. Estimated 1st stage regression models from weekly weather parameters of group II for the variety 29 - Valiyakodi

| Standard weeks | Regression coefficients for the weather parameters MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 24 | .0548 | .5736 | .1326 | -.0019 | 0 |
| 25 | .2742 | .7823 | .1682 | -.0055 | .1454 |
| 26 | -.3689 | -.5899 | .0783 | .0043 | .1526 |
| 27 | .1469 | 1.1875 | .1495 | -.0034 | 0 |
| 28 | -.3088 | -.3387 | .1649 | .0052 | .6014 |
| 29 | -.0774 | .0791 | -.3620 | -.0014 | .4464 |
| 30 | -.0287 | -1.2583 | 0 | .001 | .2766 |
| 31 | .1871 | -.5286 | 0 | -.0009 | 0 |
| 32 | -.0576 | 2.1939 | -.1099 | -.0037 | 0 |
| Intercept | 16.1861 | -152.0828 | -19.6585 | 2.8862 | -8.6640 |
| $R^2$ | .8612 | .7157 | .4830 | .8538 | .3158 |

Table 74. Estimated 2nd stage regression models from the weekly weather parameters

| Varieties | $Z_{MX.1}$ | $Z_{MX.2}$ | $Z_{MN.1}$ | $Z_{MN.2}$ | $Z_{RH.1}$ | $Z_{RH.2}$ | $Z_{RF.1}$ | $Z_{RF.2}$ | $Z_{NR.1}$ | $Z_{NR.2}$ | T | Intercept | $R^2$ | $Ra^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1 | - | - | .3156 | - | .3642 | - | .1273 | - | .2888 | .3761 | - | -.5159 | .9801 | .972 |
| 2 | - | .4086 | .1121 | .4534 | - | - | -.3135 | - | .5365 | -.2272 | - | .0133 | .998 | .998 |
| 3 | - | - | - | .6043 | - | .2558 | - | .0734 | - | .2772 | -.0281 | -.3156 | .9860 | .9841 |
| 4 | -.2755 | -.2717 | .3356 | - | - | - | .3873 | - | .9377 | - | -.0177 | .0745 | .9545 | .9293 |
| 5 | .1863 | - | - | .1996 | - | .6741 | -.1387 | - | .1822 | - | .0148 | -.3257 | .9900 | .9860 |
| 6 | - | .1785 | .0784 | .0883 | - | .4914 | - | .3257 | - | - | - | -.2004 | .996 | .994 |
| 7 | .1874 | -.1258 | - | .6896 | - | .4066 | - | - | - | - | - | -.1914 | .9940 | .992 |
| 8 | .2231 | - | .4574 | - | -.1622 | .3822 | .0988 | - | - | .1142 | .0065 | -.1658 | .992 | .9880 |
| 9 | .2868 | -.1725 | -.3683 | .3149 | - | .4113 | - | - | .2606 | .1471 | - | -.0078 | .990 | .9841 |
| 10 | .7718 | - | .1655 | - | - | - | - | .1230 | - | - | -.0204 | .0823 | .9940 | .9920 |
| 11 | .2982 | -.243 | .4697 | - | .2553 | .2547 | .3298 | - | .030 | - | - | -.5834 | .9781 | .960 |
| 12 | .0162 | - | - | - | .3678 | .5328 | .5863 | -.7475 | - | - | - | .1875 | .9683 | .9565 |
| 13 | - | .1706 | - | - | - | .7391 | - | - | - | .2184 | .0104 | -.2624 | .990 | .9880 |
| 14 | - | - | .6330 | -.2504 | - | - | - | .2885 | .5466 | - | .0145 | -.4258 | .988 | .982 |
| 15 | -.0833 | - | .6449 | .3910 | -.2646 | - | - | - | - | .5140 | -.003 | 1.9318 | .9682 | .9565 |

Contd.

Table 74. Continued

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | .2696 | - | .3929 | .3823 | .3216 | - | - | .0255 | -.2675 | - | - | -.1771 | .992 | .988 |
| 17 | .2567 | - | .0733 | - | .5382 | .0551 | - | .3293 | - | - | - | -.4610 | .9860 | .9821 |
| 18 | .4231 | - | - | .8131 | 1.2758 | - | - | -.1932 | -.6554 | - | -.0111 | -.2754 | .9781 | .9662 |
| 19 | - | - | - | .4262 | - | .5488 | - | .4615 | -.3140 | - | - | -.2135 | .988 | .984 |
| 20 | .1954 | - | .3567 | - | - | - | - | .1976 | .4391 | .1692 | - | -.2213 | .986 | .9801 |
| 21 | - | - | - | - | .4476 | .2755 | .2008 | .3541 | - | - | - | -.2756 | .9565 | .9448 |
| 22 | - | - | - | .2913 | .0883 | .4780 | - | .3319 | - | - | - | -.2863 | .9841 | .9801 |
| 23 | - | - | - | - | .2478 | .4006 | - | - | .5871 | .1409 | - | -.4041 | .9781 | .9683 |
| 24 | - | - | - | .3292 | - | .1315 | .3085 | .1570 | .0782 | .1610 | - | -.2490 | .998 | .998 |
| 25 | - | .2076 | .6963 | - | - | .2335 | - | - | - | - | .0108 | -.1405 | .984 | .9801 |
| 26 | - | .3640 | .1991 | - | - | .3050 | - | .3232 | - | - | - | -.4786 | .996 | .994 |
| 27 | .2669 | .0643 | - | .0233 | .3394 | .3878 | - | - | .3244 | - | - | -.2254 | .9682 | .9526 |
| 28 | - | - | .2421 | .2512 | .1771 | .2760 | - | - | - | .4285 | - | -.4726 | .9801 | .9742 |
| 29 | - | - | .4184 | - | .1863 | - | - | .1922 | .3185 | - | - | -.1817 | .986 | .9821 |

Table 75. Estimated first stage regression models from the fortnightly weather parameters for the variety 1 - Balankotta 1

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | -.4709 | .4309 | -.4189 | -.0268 | -.1429 |
| 9 | -.1004 | -.0993 | .3263 | .0078 | .657 |
| 10 | .5872 | -.276 | .2329 | -.0185 | -.1751 |
| 11 | .2127 | .232 | -.4014 | 0 | .1775 |
| 12 | .1635 | -.4869 | .1789 | -.0042 | 0 |
| 13 | -.2098 | 0 | .0481 | .0073 | .5814 |
| 14 | .1974 | -.9401 | -.1435 | .0086 | -.7891 |
| 15 | .0367 | .1277 | .0752 | -.0002 | .2454 |
| 16 | -.2147 | -.9917 | -.3611 | 0 | .6959 |
| Intercept | -16.2926 | 146.8337 | 45.2356 | -2.758 | -8.9547 |
| $R^2$ | .6022 | .5610 | .6626 | .4816 | .51 |

Table 76. Estimated first stage regression models from the fortnightly weather parameters for the variety 2 - Balankotta 2

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | -.0396 | -.1382 | .0501 | .0051 | 0 |
| 9 | -.0566 | -.0873 | .1071 | .0008 | .0743 |
| 10 | .205 | 0 | -.07 | -.0005 | -.0532 |
| 11 | .0052 | .1383 | .0082 | .0025 | .1073 |
| 12 | -.0494 | -.1418 | -.0398 | .0001 | 0 |
| 13 | .0240 | 0 | .2081 | .0024 | .1862 |
| 14 | -.0039 | -.1861 | -.2507 | .0006 | -.2003 |
| 15 | .0215 | .0168 | .0009 | -.0015 | 0 |
| 16 | 0 | -.1809 | -.1285 | 0 | .0685 |
| Intercept | -8.7660 | 43.544 | 21.6696 | -.2978 | -.1483 |
| $R^2$ | .5610 | .4330 | .7056 | .6577 | .3733 |

Table 77. Estimated first stage regression models from the fortnightly weather parameters for the variety 3 - Cheriya Kariyakadan

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | -.7100 | .1101 | -.3939 | 0 | -.1019 |
| 9 | -.0928 | 0 | .5209 | -.0023 | .434 |
| 10 | .7369 | 0 | -.0048 | -.0153 | -.4015 |
| 11 | .1825 | .1276 | -.3422 | -.0057 | .2211 |
| 12 | .2037 | -.066 | -.0106 | -.0005 | -.2061 |
| 13 | -.1071 | .180 | .400 | .0038 | .5157 |
| 14 | .0209 | -1.5854 | -.258 | .0037 | -.5026 |
| 15 | -.0177 | .0433 | .0011 | .0019 | .0222 |
| 16 | .0227 | -.5858 | -.13 | .0022 | .4661 |
| Intercept | -17.3040 | 130.6216 | 21.3871 | -.358 | -2.0487 |
| $R^2$ | .6642 | .4556 | .7903 | .5213 | .6273 |

Table 78. Estimated first stage regression models from the fortnightly weather parameters for the variety 4 - Chumala

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | 0.0 | .2068 | -.0293 | -.0035 | 0 |
| 9 | -.1634 | -.057 | .039 | .0057 | .0167 |
| 10 | .0949 | -.2143 | .0403 | -.001 | 0 |
| 11 | .0890 | 0 | -.1086 | .0005 | -.0773 |
| 12 | .0258 | .0501 | -.016 | -.0017 | -.0544 |
| 13 | -.0152 | 0 | .0366 | .0015 | -.0492 |
| 14 | .0585 | 0 | 0 | .0013 | .2277 |
| 15 | .0072 | .0385 | .0072 | -.0011 | 0 |
| 16 | -.0163 | -.1913 | .0491 | -.0005 | -.2113 |
| Intercept | -5.990 | 12.6122 | -1.4871 | .3389 | 1.6761 |
| $R^2$ | .8263 | .4147 | .5069 | .6273 | .5806 |

Table 79. Estimated first stage regression models from the fortnightly weather parameters for the variety 5 - Kalluvally 1

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | .1130 | -.2783 | .0423 | .0024 | -.0578 |
| 9 | 0.0 | .0672 | -.0436 | 0 | 0 |
| 10 | .156 | -.3017 | .0296 | .0062 | .0907 |
| 11 | -.0857 | .3333 | .0695 | .0033 | .1502 |
| 12 | 0.0 | -.2886 | -.0613 | .0003 | .0235 |
| 13 | -0.0435 | -.6471 | .3006 | .0028 | .0226 |
| 14 | 0.0 | .4744 | -.4151 | -.0002 | -.1918 |
| 15 | .0367 | .0145 | .0013 | -.0007 | .1403 |
| 16 | 0.0 | -.0994 | -.2347 | -.0012 | 0 |
| Intercept | -15.1240 | 55.8336 | 31.2660 | -.6115 | -1.2086 |
| $R^2$ | .2959 | .5776 | .7225 | .6529 | .6416 |

Table 80. Estimated first stage regression models from the fortnightly weather parameters for the variety 6 - Kalluvally 2

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | -.1267 | -.4586 | -.0634 | 0 | .0306 |
| 9 | .0368 | .1882 | .0178 | -.0045 | .1446 |
| 10 | .2840 | -.3387 | .0362 | .0044 | .0166 |
| 11 | -.1048 | .3117 | .0564 | .0003 | .152 |
| 12 | .1126 | -.4648 | -.0367 | .0015 | .0289 |
| 13 | -.1361 | -.9675 | .3892 | .0010 | .2796 |
| 14 | .183 | .5684 | -.3525 | -.0015 | -.4543 |
| 15 | .0043 | -.0048 | -.0096 | .0015 | .1081 |
| 16 | 0.0 | -.1956 | -.3005 | -.002 | .0615 |
| Intercept | -20.960 | 102.011 | 27.0341 | 1.2851 | .1538 |
| $R^2$ | .5069 | .5883 | .9254 | .6659 | .8190 |

Table 81. Estimated first stage regression models from the fortnightly weather parameters for the variety 7 - Kalluvally 3

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | 0.0 | .0456 | .1709 | -.0057 | 0 |
| 9 | 0.0 | -.1456 | -.1453 | .0054 | -.1723 |
| 10 | .0343 | -.107 | .1162 | .0101 | .1743 |
| 11 | 0.0 | .2853 | 0 | .0056 | .0799 |
| 12 | .083 | .0837 | 0 | -.0004 | 0 |
| 13 | 0 | -.3036 | .1867 | .0028 | 0.1665 |
| 14 | 0 | .491 | -.2238 | .0006 | .1971 |
| 15 | .0272 | .0058 | 0 | -.0022 | .1062 |
| 16 | -.2118 | .1561 | -.2088 | 0 | -.1568 |
| Intercept | 6.2172 | -36.4708 | 12.5943 | -.9639 | -3.4035 |
| $R^2$ | .2265 | .7975 | .4083 | .5270 | .4747 |

Table 82. Estimated first stage regression models from the fortnightly weather parameters for the variety 8 - Kaniyakadan

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | 0.0 | -.1395 | -.0858 | .0054 | -.1558 |
| 9 | .1199 | -.069 | .0263 | -.0011 | .0572 |
| 10 | 0 | 0.0 | .0578 | .0028 | .0372 |
| 11 | .0087 | 0 | -.0136 | -.0031 | .104 |
| 12 | 0 | 0 | .0293 | .0027 | -.0196 |
| 13 | .0607 | 0 | .0234 | 0 | 0 |
| 14 | .0524 | 0 | -.3479 | -.0005 | -.267 |
| 15 | -.0074 | -.0219 | .0066 | .0021 | -.1093 |
| 16 | .0881 | 0 | -.0427 | .0005 | .0485 |
| Intercept | -17.3006 | 18.4285 | 34.4589 | -.6109 | 4.9435 |
| $R^2$ | .3770 | .1815 | .8501 | .5184 | .5285 |

Table 83. Estimated first stage regression models from the fortnightly weather parameters for the variety 9 - Karivilanchy

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | 0 | -.0888 | .0682 | -.0013 | .0327 |
| 9 | 0 | -.0493 | -.0161 | -.0005 | -.0531 |
| 10 | -.1277 | .0553 | 0 | .0033 | .029 |
| 11 | -.109 | .1786 | .0396 | .0028 | .0945 |
| 12 | .081 | .008 | -.0598 | -.0003 | .0085 |
| 13 | 0 | -.2061 | .2361 | .0016 | .2131 |
| 14 | 0 | .098 | -.1745 | 0 | -.0244 |
| 15 | .0159 | -.0036 | -.0073 | -.0008 | .0996 |
| 16 | -.0884 | .1055 | -.1125 | -.0002 | .0259 |
| Intercept | -2.465 | -7.0162 | 3.7010 | -.1919 | -3.9294 |
| $R^2$ | .2884 | .5898 | .5344 | .5314 | .6384 |

Table 84. Estimated first stage regression models from the fortnightly weather parameters for the variety 10 - Karimunda 1

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | .1627 | -.224 | -.0748 | -.0019 | -.0745 |
| 9 | .1683 | -.2128 | -.0093 | .0004 | .0928 |
| 10 | -.0863 | .1446 | .2233 | .0034 | 0 |
| 11 | .0097 | .0474 | -.1297 | -.0029 | -.0383 |
| 12 | .0672 | .1815 | .068 | .0009 | 0 |
| 13 | -.1007 | -.2257 | -.0029 | .0010 | .1013 |
| 14 | -.0437 | -.0565 | .0680 | -.0001 | 0 |
| 15 | .0069 | -.008 | .0205 | .0015 | .1541 |
| 16 | .0839 | -.0781 | -.4455 | .0001 | .0394 |
| Intercept | -24.5110 | 33.4146 | 29.1328 | .3644 | -2.0787 |
| $R^2$ | .6432 | .6593 | .7396 | .6496 | .4045 |

Table 85. Estimated first stage regression models from the fortnightly weather parameters for the variety 11 - Karimunda 2

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | .3805 | -.3798 | .2376 | .0088 | .0956 |
| 9 | .1852 | -.0962 | -.2445 | .0023 | -.2892 |
| 10 | -.1507 | .1348 | -.0041 | .0051 | .1677 |
| 11 | -.0487 | .1108 | .0986 | -.002 | -.1226 |
| 12 | 0 | .1746 | -.1231 | .0021 | .1205 |
| 13 | -.0665 | -.0587 | -.0135 | .0013 | -.0808 |
| 14 | -.2135 | .3401 | .0765 | .0005 | .3902 |
| 15 | 0 | -.0576 | -.0286 | .005 | 0 |
| 16 | .0948 | .3237 | -.1643 | -.0003 | -.2504 |
| Intercept | -19.057 | -33.8221 | 17.6296 | -.6177 | -.0358 |
| $R^2$ | .4583 | .8226 | .7345 | .6480 | .6480 |

Table 86. Estimated first stage regression models from the fortnightly weather parameters for the variety 12 - Karimunda 3

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | -.0323 | .0242 | -.0033 | -.0034 | -.0619 |
| 9 | -.003 | -.0331 | -.0193 | .0033 | 0 |
| 10 | .0905 | .0155 | .055 | .0005 | 0 |
| 11 | .0031 | .0173 | -.0385 | -.0006 | -.0277 |
| 12 | .1057 | .1515 | -.0489 | -.0004 | -.0232 |
| 13 | -.014 | 0 | .0469 | .0017 | .0408 |
| 14 | .0095 | -.0643 | -.0017 | .0011 | .0606 |
| 15 | -.0007 | .0062 | -.0023 | 0 | .0484 |
| 16 | -.0462 | -.0791 | -.0601 | .0005 | 0 |
| Intercept | -9.636 | -2.3496 | 7.5659 | -.6516 | -.6738 |
| $R^2$ | .8500 | .5256 | .5715 | .8575 | .3844 |

Table 87. Estimated first stage regression models from the fortnightly weather parameters for the variety 13 - Karivally

| Fortnight | Regression coefficient | | | | |
| --- | --- | --- | --- | --- | --- |
| | MXT | MNT | RH | RF | NR |
| 8 | -.0391 | -.1711 | .0908 | -.005 | .1181 |
| 9 | -.0084 | .0169 | .0493 | .0023 | -.0646 |
| 10 | .3258 | -.0411 | 0 | -.0023 | .0386 |
| 11 | -.011 | .2968 | 0 | .0004 | 0 |
| 12 | .108 | -.1471 | -.1265 | 0 | .1048 |
| 13 | -.1037 | -.2901 | .2469 | .0039 | .2927 |
| 14 | -.0688 | .0472 | 0 | .0029 | 0 |
| 15 | .0112 | -.0094 | -.0275 | -.0006 | .0645 |
| 16 | -.1038 | -.0924 | -.3167 | -.0009 | 0 |
| Intercept | -10.97 | 29.4995 | 18.9927 | -1.0093 | -4.2654 |
| $R^2$ | .6561 | .7939 | .4651 | .7586 | .4070 |

Table 88. Estimated first stage regression models from the fortnightly weather parameters for the variety 14 - Kottanadan

| Fortnight | Regression coefficient | | | | |
| --- | --- | --- | --- | --- | --- |
| | MXT | MNT | RH | RF | NR |
| 8 | 0 | -.1826 | .0408 | .0050 | .2123 |
| 9 | 0 | -.0105 | -.0372 | 0 | .076 |
| 10 | .0697 | -.2187 | -.0626 | .0035 | 0 |
| 11 | 0 | .0108 | .0186 | 0 | 0 |
| 12 | 0 | -.0009 | .0076 | .0016 | .0339 |
| 13 | 0 | .2791 | .2951 | .0002 | .1529 |
| 14 | 0 | -.3498 | -.1467 | -.0009 | -.3785 |
| 15 | .0109 | .0328 | -.026 | 0 | .0812 |
| 16 | 0 | -.2721 | .0199 | .0009 | .2058 |
| Intercept | -6.018 | 54.6579 | -9.3289 | .1507 | .0346 |
| $R^2$ | .127 | .6561 | .6480 | .3697 | .4802 |

Table 89. Estimated first stage regression models from the fortnightly weather parameters for the variety 15 - Kumbhakodi

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | -.2664 | .1666 | -.1185 | .0108 | -.2577 |
| 9 | .0326 | .233 | .28 | 0 | .0948 |
| 10 | -.0939 | -1.2243 | -.0978 | -.0056 | -.0949 |
| 11 | .5785 | .3761 | -.3351 | 0 | .1084 |
| 12 | -.4147 | -.9187 | .2181 | 0 | -.1157 |
| 13 | -.1031 | -.2436 | .3697 | 0 | 0 |
| 14 | .2361 | -.8993 | -.8726 | 0 | -.6168 |
| 15 | .0354 | .0954 | .02 | -.0018 | -.2642 |
| 16 | .2323 | -.9788 | .1486 | 0 | 0 |
| Intercept | -16.51 | 251.7262 | 39.080 | 2.9649 | 14.6848 |
| $R^2$ | .6273 | .6872 | .9526 | .144 | .4462 |

Table 90. Estimated first stage regression models from the fortnightly weather parameters for the variety 16 - Kuthiravally

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | .4458 | -.2379 | .012 | -.0012 | .2167 |
| 9 | .1015 | -.1183 | -.1603 | -.0012 | .0302 |
| 10 | -.1609 | -.4816 | .3886 | .0157 | .2567 |
| 11 | -.0405 | .2447 | -.1512 | -.0004 | -.1057 |
| 12 | .1301 | .1617 | .0388 | .0004 | .0391 |
| 13 | -.1624 | -.8128 | .0841 | .0009 | .1921 |
| 14 | -.1221 | .5615 | -.0497 | -.0014 | .1004 |
| 15 | .0288 | .0248 | .0303 | -.0001 | .214 |
| 16 | .0517 | -.1703 | -.5222 | -.0018 | -.1384 |
| Intercept | -26.845 | 63.5455 | 34.2677 | 1.3062 | -4.5101 |
| $R^2$ | .6131 | .8780 | .7975 | .7656 | .7674 |

Table 91. Estimated first stage regression models from the fortnightly weather parameters for the variety 17 - Kuthiravally-AR

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | -.1248 | .181 | -.3952 | 0 | -.1564 |
| 9 | .0542 | .5179 | .2626 | -.0054 | .4797 |
| 10 | .1527 | -.6052 | .0756 | -.0034 | -.1916 |
| 11 | .0544 | -.048 | -.1002 | -.0045 | .1384 |
| 12 | .1353 | 0 | -.1469 | -.0005 | -.21 |
| 13 | 0 | -.0979 | .1259 | .0017 | .3041 |
| 14 | 0 | -.8268 | -.2641 | .0015 | -.7187 |
| 15 | .0002 | .0707 | .009 | .0018 | .0449 |
| 16 | .1069 | -.8235 | .2210 | .0025 | .6608 |
| Intercept | -31.7316 | 120.3039 | 20.5891 | -.0502 | -.3083 |
| $R^2$ | .4356 | .5126 | .8046 | .5271 | .7744 |

Table 92. Estimated first stage regression models from the fortnightly weather parameters for the variety 18 - Munda

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | .0526 | 0 | -.0196 | 0 | .0741 |
| 9 | .0158 | -.114 | .009 | -.0015 | 0 |
| 10 | .0424 | .0156 | .090 | -.0016 | .021 |
| 11 | .0718 | .0276 | -.121 | -.0026 | -.0598 |
| 12 | .0545 | .1245 | -.0078 | -.0004 | -.0218 |
| 13 | -.1046 | 0 | .019 | .0012 | 0 |
| 14 | -.0516 | -.1496 | .0741 | .0014 | .1672 |
| 15 | .0052 | 0 | .0045 | .0007 | 0 |
| 16 | .056 | 0 | -.1024 | -.0004 | -.1292 |
| Intercept | -13.21 | 7.7922 | 5.8763 | .0181 | .4987 |
| $R^2$ | .8409 | .2916 | .7686 | .750 | .4160 |

Table 93. Estimated first stage regression models from the fortnightly weather parameters for the variety 19 - Narayakodi

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | 0 | -.2497 | -.1108 | .0016 | -.0284 |
| 9 | 0 | .2443 | -.0105 | -.0018 | .1597 |
| 10 | .2002 | -.7779 | .1650 | .0062 | .1377 |
| 11 | -.0441 | .3645 | -.0266 | .0004 | .1414 |
| 12 | .0940 | -.5237 | .0161 | .0006 | 0 |
| 13 | -.1532 | -1.0499 | .1727 | .0020 | .1847 |
| 14 | .1391 | .6708 | -.4596 | 0 | -.3754 |
| 15 | .0238 | .0398 | .0338 | .0008 | .0887 |
| 16 | 0.0 | -.374 | -.2457 | -.0021 | .0203 |
| Intercept | -21.6 | 124.7988 | 47.2449 | .972 | 1.672 |
| $R^2$ | .3919 | .6368 | .8556 | .5550 | .7362 |

Table 94. Estimated first stage regression models from the fortnightly weather parameters for the variety 20 - Palulauta

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | -.0913 | -.090 | -.0973 | 0 | 0 |
| 9 | -.0975 | -.125 | .1593 | 0 | .1354 |
| 10 | .2232 | -.0076 | .017 | -.0035 | -.1244 |
| 11 | .0692 | .055 | -.123 | .0005 | .0044 |
| 12 | -.0014 | -.0693 | .0153 | -.0012 | .0266 |
| 13 | -.0452 | -.0685 | .168 | .0018 | .1692 |
| 14 | -.0006 | -.2818 | .0608 | .0006 | -.0287 |
| 15 | .0107 | .0316 | .0072 | -.001 | .1134 |
| 16 | .0295 | -.2828 | -.2997 | -.0009 | .0122 |
| Intercept | -8.061 | 62.2675 | 9.4571 | .9432 | -2.3915 |
| $R^2$ | .6839 | .7691 | .990 | .5476 | .6691 |

Table 95. Estimated first stage regression models from the fortnightly weather parameters for the variety 21 - Perumkodi

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | .3836 | -.2142 | -.0942 | -.003 | 0 |
| 9 | .147 | .3841 | -.0912 | -.0033 | .1595 |
| 10 | -.1686 | -.6784 | .1974 | .0034 | .1609 |
| 11 | .0304 | .2359 | -.0236 | -.002 | .0086 |
| 12 | -.0126 | -.3323 | -.0494 | -.005 | .0258 |
| 13 | -.1759 | -.9911 | -.0279 | .0017 | .1136 |
| 14 | -.0004 | .6121 | -.1459 | .0011 | -.2694 |
| 15 | .0399 | .0349 | .0328 | .0012 | .1175 |
| 16 | .137 | -.4132 | -.2028 | -.0025 | .0937 |
| Intercept | -35.8606 | 101.6777 | 39.7937 | .6327 | -.8028 |
| $R^2$ | .7569 | .6973 | .8798 | .8299 | .6593 |

Table 96. Estimated first stage regression models from the fortnightly weather parameters for the variety 22 - Perumunda

| Fortnight | Regression coefficient | | | | |
|---|---|---|---|---|---|
| | MXT | MNT | RH | RF | NR |
| 8 | -.2223 | -.111 | -.2989 | 0 | -.0317 |
| 9 | -.0004 | .2759 | .2487 | -.0066 | .2973 |
| 10 | .1197 | -.6162 | .1361 | 0 | -.0731 |
| 11 | .0682 | .2055 | -.1401 | -.0025 | .199 |
| 12 | 0 | -.4744 | .0883 | 0 | -.1452 |
| 13 | -.1293 | -.9853 | .2478 | 0 | .1952 |
| 14 | .2084 | .1366 | -.4511 | -.0013 | -.5292 |
| 15 | 0 | .0272 | .0284 | .0024 | -.0305 |
| 16 | .165 | -.3505 | -.0855 | -.0013 | .083 |
| Intercept | -14.74 | 140.655 | 23.4908 | 2.4329 | 5.2439 |
| $R^2$ | .4886 | .6529 | .8574 | .3192 | .8172 |

Table 97. Estimated first stage regression models from the fortnightly weather parameters for the variety 23 - Sullia

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | 0 | 0 | -.1371 | 0 | .1459 |
| 9 | .0766 | 0 | .1168 | -.0061 | .1671 |
| 10 | .0288 | -.185 | .0709 | .0012 | 0 |
| 11 | 0 | .1722 | -.0589 | 0 | .1775 |
| 12 | 0 | -.1733 | .0323 | .0003 | -.042 |
| 13 | -.0876 | -.2951 | .1883 | 0 | .2816 |
| 14 | 0 | -.0981 | -.3061 | -.0002 | -.361 |
| 15 | .0209 | .0142 | .015 | .001 | .0314 |
| 16 | .0613 | 0 | -.0135 | -.0003 | .1956 |
| Intercept | -8.437 | 42.6533 | 10.1964 | .9896 | -1.747 |
| $R^2$ | .2862 | .4096 | .6480 | .4058 | .7639 |

Table 98. Estimated first stage regression models from the fortnightly weather parameters for the variety 24 - Taliparamba-I

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | -.0534 | 0 | -.2127 | .008 | -.2069 |
| 9 | 0 | .1249 | .2318 | -.0028 | .1194 |
| 10 | .0962 | -.4371 | .0339 | 0 | -.1025 |
| 11 | .1324 | .0756 | -.1275 | -.0044 | .1006 |
| 12 | -.0587 | -.0946 | -.0324 | .0023 | -.1185 |
| 13 | 0 | 0 | .1329 | .008 | .0883 |
| 14 | -.0319 | -.6582 | -.3485 | 0 | -.144 |
| 15 | -.0085 | .0201 | .008 | .0014 | -.1577 |
| 16 | .173 | -.4914 | -.0773 | .0012 | 0 |
| Intercept | -20.725 | 108.563 | 39.5524 | -.1352 | 5.293 |
| $R^2$ | .4692 | .4290 | .9101 | .4597 | .5431 |

Table 99. Estimated first stage regression models from the fortnightly weather parameters for the variety 25 - Taliparamba-II

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | 0.0 | -.2634 | .0309 | .003 | .162 |
| 9 | -.0515 | -.1676 | .021 | -.0019 | -.0051 |
| 10 | .1351 | .1344 | .0147 | .0015 | -.0275 |
| 11 | 0 | .0558 | -.0284 | .0008 | -.0487 |
| 12 | .0279 | .0513 | -.0195 | -.0002 | .0417 |
| 13 | -.0512 | -.1273 | .1667 | .0006 | .1408 |
| 14 | -.061 | .0322 | .1501 | -.0008 | .1285 |
| 15 | 0 | -.0043 | -.0103 | -.0008 | .1225 |
| 16 | 0 | .014 | -.3231 | -.0013 | -.1002 |
| Intercept | -.4974 | 21.1386 | .5384 | 1.3073 | -3.6787 |
| $R^2$ | .3069 | .7903 | .7006 | .6053 | .6724 |

Table 100. Estimated first stage regression models from the fortnightly weather parameters for the variety 26 - Taliparamba-III

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | 0 | -.3406 | -.0765 | -.004 | .1003 |
| 9 | 0 | .319 | -.0245 | -.0067 | .173 |
| 10 | .2126 | -.5585 | .132 | .007 | .1012 |
| 11 | -.1184 | .3379 | .0355 | .0005 | .1204 |
| 12 | .1434 | -.4466 | -.0501 | .0003 | .0274 |
| 13 | -.1597 | -1.2356 | .3103 | .0006 | .3139 |
| 14 | .1415 | .7759 | -.3024 | -.0015 | -.4228 |
| 15 | .0129 | .0164 | .0067 | .001 | .1505 |
| 16 | -.0156 | -.2842 | -.2880 | -.0029 | .0749 |
| Intercept | -18.75 | 105.545 | 26.1394 | 1.9086 | -2.1291 |
| $R^2$ | .4733 | .6939 | .9101 | .7191 | .9331 |

Table 101. Estimated first stage regression models from the fortnightly weather parameters for the variety 27 - Taliparamba-IV

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | -.1984 | .0461 | -.1311 | 0 | .164 |
| 9 | 0 | -.0371 | .1386 | -.0039 | .0999 |
| 10 | .1785 | -.1522 | .0892 | 0 | -.0347 |
| 11 | .0207 | .1091 | -.1453 | -.0017 | .0837 |
| 12 | .1026 | -.0856 | .0666 | 0 | .0586 |
| 13 | -.1052 | -.193 | .1122 | -.0004 | .1638 |
| 14 | 0 | -.2455 | -.131 | 0 | -.0795 |
| 15 | -.0106 | .0052 | .0083 | .0012 | -.0475 |
| 16 | .019 | -.0068 | -.0146 | 0 | 0 |
| Intercept | .1626 | 41.3713 | 1.3133 | .6998 | -.2014 |
| $R^2$ | .4476 | .6178 | .6529 | .2470 | .5256 |

Table 102. Estimated first stage regression models from the fortnightly weather parameters for the variety 28 - Valli

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | -.2104 | .1192 | -.0753 | 0 | -.0997 |
| 9 | -.1422 | -.0993 | .1235 | .0042 | .0724 |
| 10 | .3415 | -.2241 | 0 | -.0032 | 0 |
| 11 | .0794 | .1791 | -.121 | 0 | .0531 |
| 12 | .0537 | -.2768 | .0362 | 0 | 0 |
| 13 | -.0636 | -.1387 | .1839 | .0025 | .0804 |
| 14 | .1119 | -.1237 | -.1615 | .0017 | 0 |
| 15 | .0188 | .0557 | .0151 | 0 | 0 |
| 16 | -.1157 | -.3871 | -.1536 | -.0002 | -.1102 |
| Intercept | -4.301 | 66.95 | 15.8532 | -.5975 | 1.3231 |
| $R^2$ | .7006 | .6053 | .558 | .3102 | .326 |

Table 103. Estimated first stage regression models from the fortnightly weather parameters for the variety 29 - Valiyakodi

| Fortnight | Regression coefficient MXT | MNT | RH | RF | NR |
|---|---|---|---|---|---|
| 8 | .505 | -.0769 | -.011 | -.0042 | .4728 |
| 9 | .1442 | -.2049 | -.1797 | -.002 | .0974 |
| 10 | -.2133 | -.235 | .3500 | .0084 | .2682 |
| 11 | -.135 | .1412 | -.1102 | .0018 | -.03 |
| 12 | .1172 | .1537 | .1194 | -.0011 | .0905 |
| 13 | -.1671 | -.3111 | -.1465 | .0006 | .2255 |
| 14 | -.2251 | .4306 | .1057 | .0011 | 0 |
| 15 | .0474 | .0322 | .0514 | 0 | .2355 |
| 16 | -.0043 | .1584 | -.254 | -.0012 | .1017 |
| Intercept | -9.55 | -3.6930 | 9.5799 | .9015 | -8.3107 |
| $R^2$ | .7379 | .6022 | .6577 | .6084 | .8519 |

Table 104. Estimated 2nd stage regression models from fortnightly weather parameters

| Varieties | $Z_{MX}$ | $Z_{MN}$ | $Z_{RH}$ | $Z_{RF}$ | $Z_{NR}$ | Intercept | $R^2$ | $Ra^2$ ? |
|---|---|---|---|---|---|---|---|---|
| 1 | .5517 | - | .4282 | -.0651 | .4858 | -.4252 | .8836 | .8519 |
| 2 | .4458 | .2867 | .6157 | .1989 | - | -.5749 | .852 | .810 |
| 3 | .5100 | .2234 | .4131 | -.1852 | .3236 | -.1141 | .931 | .804 |
| 4 | .8766 | - | .2293 | - | - | -.0534 | .840 | .828 |
| 5 | .3836 | .3533 | .7348 | - | - | -.5129 | .8408 | .8136 |
| 6 | - | - | .7244 | - | .3437 | -.0866 | .9506 | .9467 |
| 7 | - | .8624 | .3639 | - | - | -.2726 | .8354 | .8226 |
| 8 | .4944 | -.8638 | .9814 | .2261 | - | .1515 | .9390 | .9216 |
| 9 | .4402 | .5432 | .5922 | - | .0715 | -.3203 | .810 | .7569 |
| 10 | .5621 | .6010 | .4094 | -.2660 | - | -.3943 | .9120 | .889 |
| 11 | .2526 | .5555 | .3224 | - | .2102 | -.5001 | .9467 | .9312 |
| 12 | 1.0325 | - | - | -.0358 | - | .0207 | .8538 | .8427 |
| 13 | .4463 | .7149 | - | - | - | -.2109 | .8612 | .8501 |
| 14 | -.3768 | .7439 | .6717 | - | - | -.0514 | .8761 | .8538 |
| 15 | - | - | 1.0000 | - | - | .0009 | .9526 | .9526 |
| 16 | - | .6516 | .4778 | - | - | -.1835 | .9526 | .9487 |
| 17 | .3529 | - | .4540 | - | .5383 | -.6041 | .9351 | .9254 |
| 18 | .7797 | - | .3125 | -.1945 | .3743 | -.1580 | .8949 | .8668 |
| 19 | .2527 | .2464 | .7576 | - | - | -.4896 | .9044 | .8874 |
| 20 | - | - | .9971 | .0354 | - | -.0212 | .992 | .992 |
| 21 | .3188 | .3144 | .5063 | - | - | -.1717 | .935 | .9254 |
| 22 | .3214 | .1482 | .7888 | .1458 | - | -.6116 | .9722 | .9643 |
| 23 | - | .4667 | .3482 | .1581 | .5617 | -.7061 | .8987 | .8705 |
| 24 | - | - | 1.0312 | - | - | -.7449 | .9006 | .9006 |
| 25 | - | .6972 | - | - | .4596 | .0605 | .8593 | .8501 |
| 26 | - | - | .5543 | .1390 | .3909 | -.0575 | .9781 | .9821 |
| 27 | .3266 | .3430 | .4390 | - | .3497 | -.2611 | .8281 | .781 |
| 28 | .6094 | .4455 | - | -.1988 | .4477 | -.5316 | .8686 | .8336 |
| 29 | .2278 | .4132 | .3060 | -.5612 | .7826 | -.1604 | .9643 | .9487 |

# Summary

# SUMMARY

Influence of five weather parameters viz. maximum temperature, minimum temperature, relative humidity, rainfall and number of rainy days on the yield of 29 varieties of pepper were studied at different lag periods. Daily observations on weather elements and annual yield of pepper recorded at the Pepper Research Station, Panniyoor, situated in Cannanore District of Kerala State, were used for the purpose.

The critical period of crop production for pepper was taken as 18 standard weeks or equivalently 9 fortnights during April to August. Each weather element in a standard week and similarly in a fortnight was considered as a variable. Thus for each weather element there were 18 standard weeks and 9 fortnights.

Coefficients of correlation between the weather parameters of each standard week and fortnight in the critical period of the crop production (from 15th standard week to 32nd standard week) and yield of each of the 29 varieties were worked out. There was no uniformity among the varieties with respect to the influence by weather variables of various lag periods

due to large genotype-environment interaction. More over when individual week or fortnights were considered only very few significant relationship with yield could be observed.

Correlogram for five selected varieties were drawn to get the pattern of relationship. Here again there was no uniformity among varieties.

Forecasting models from weekly data

Two stage linear regression was used to estimate yield forecasting models for the 29 varieties of pepper. When weekly observations were considered, the number of explanatory variables to be taken in to account was very large and hence they were classified into 10 groups. The standard weeks during the critical period were divided into two and each weather element for one group was considered as one set of explanatory variables. Thus altogether there were 10 sets of explanatory variables.

Multiple linear regression of annual yield on the explanatory variables in each set was worked out for all the 29 varieties and they formed the first stage forecasting models.

The estimated yield from the first stage models were taken as the explanatory variables for the models at the second stage. At the second stage also, regression of annual yield of each variety of pepper on the ten estimated yields from the first stage models and the trend variable was done by step-wise regression.

Forecasting models from fortnightly data

Here also two stage linear regression models were used. The only deviation from that from weekly data is that each weather element in various fortnights were grouped in to one set of explanatory variables. Thus there were five sets of explanatory variables in this case.

Multiple linear regression of yield of each variety on the variables in each set was done and they formed the first stage models. At the second stage, estimated yields from the five first stage models constituted the explanatory variables available for selection in the step-wise regression for each of the 29 varieties considered.

For most of the varieties one of the first stage models could be used to forecast annual yield with remarkable accuracy.

In general the models using weekly weather data have high predictability compared to those from fortnightly data. More over almost all final forecasting models during weekly data have predictability more than 98 per cent.

Though weather elements in standard weeks or fortnights, when considered individualy, were not having very high relationship with annual yield of most of the varieties, their cumulative effect is substantial to the extend that annual yield can be predicted from weather elements with very negligible error in prediction.

# References

REFERENCES

*Anonymous (1954). Annu. Rep. 1953-56. Pepper Research Scheme Madras State, Directorate of Agriculture, Madras.

Abeywardena, V. (1968). Forecasting coconut crops using rainfall data. Ceylon Cocon. Quart., 19:161-176.

Afifi, A.A. and Azen, S.P. (1979). Statistical analysis. A Computer oriented approach, 2nd ed. Academic Press, London. 442p.

Balasubramaniam, C. (1956). Rainfall and yield of coconut in South Kanara District. Indian Cocon. J. 9: 207-214.

Deshpande, R.S. (1981). Bibiliography on crop-weather relationships. Indian J. Agric. Econ. 35(2): 144-151.

Devanathan, M.A.V. (1975). Weather and yield of a crop. Expl. Agric. 11:183-186.

Devuyst, A. (1948). Influence des pluies sur les rendements du palmier a huile enregistres a la station de Ls Me de 1938 a 1946. Oleagineux, 3:137-144.

George, C.K. (1989). Accent on value addition. The Hindu Survey of Indian Agriculture 1986. 148-149.

*Hemptinae, J. and Ferwerde, J.D. (1961). Influence des precipilation sur les production du palmier a' huile. Oleagineux. 16:431-437.

Ibrahim, K.K., Pillay, V.S. and Sisikumaran, S. (1985). Genotypes season interaction and stability parameters in black pepper. Agric. Res. J. Kerala. 23(2):152-162.

*Laycock, D.H. (1964). An emperical correlation between weather and yearly tea yield in Malawi. Trop. Agric. 41:277.

Menon, R. (1981). Growth, flowering, floral biology and spike shedding in pepper. Unpublished M.Sc. thesis submitted to Kerala Agricultural University.

Menon, Usha, R. (1987). Forecasting models for crop yield in cashew. Unpublished M.Sc. thesis submitted to Kerala Agricultural University.

Mustafi, A. and Choudhari, A.S. (1981). Use of multilayer group method of data handling for predicting crop production. J. Indian Soc. Agric. Stat. 33(1):89-101.

Nair, B.P. (1985). Influence of weather parameters on the yield of coconut. Unpublished M.Sc. thesis submitted to Kerala Agricultural University.

Nalini, P.V. (1963). Flower bud differentiation in pepper. Unpublished M.Sc. thesis submitted to Kerala Agricultural University.

Patel, J.S. and Anandan, A.P. (1936). Rainfall and yield of coconut. Madras Agric. J. 24(1):9-15.

Paulose, T.T. (1973b). Pepper cultivation in India. Proceedings of a conference on spices. 10-14 April 1972 London. Trop. Products Institute.

Pillay, V.S., Sasikumaran, S. and Ibrahim, K.K. (1988) Effect of rainfall pattern on the yield of pepper. Agrometeorology of plantation crops - Proceedings of the national seminar organised by Kerala Agricultural University at Regional Agricultural Research Station, Pilicode.

Rao, G.S.L.H.V.P. (1982). Rainfall and coconut yield in the Pilicode region. North Kerala. Proceedings of PLACROSYM - 1982. pp.388-393.

Robertson, G.S. and Foong, S.F. (1976). Weather based yield forecasts for oil palm fresh fruits bunches. Malaysian Int. Agric. Oil Palm. Conf., 1976. Paper No.50, Kaula Lumpur, Malaysia.

*Sen, A.R., Biswas, O.O., Ajit, K. and Sanyal, D.K. (1966). J. Appl. Meteorol. 5:789.

Sparnaaij, L.D., Rees, A.R., Chapas, L.C. (1963). Annual yield variational in the oil palm. J. West Afr. Inst. Oil Palm Res., 4:111-125.

Swe, M. (1985). Forecasting models for the yield of coconut. Unpublished M.Sc. thesis submitted to Kerala Agricultural University.

* Original not seen

# Appendices

APPENDIX - I

| Standard week No. | Month | Date | Standard week No. | Month | Date |
|---|---|---|---|---|---|
| 1 | January | 1-7 | 27 | July | 2-8 |
| 2 | | 8-14 | 28 | | 9-15 |
| 3 | | 15-21 | 29 | | 16-22 |
| 4 | | 22-28 | 30 | | 23-29 |
| 5 | | 29-4 | 31 | | 30-5 |
| 6 | February | 5-11 | 32 | August | 6-15 |
| 7 | | 12-18 | 33 | | 13-19 |
| 8 | | 19-25 | 34 | | 20-26 |
| 9 | | 26-4* | 35 | | 27-2 |
| 10 | March | 5-11 | 36 | September | 3-9 |
| 11 | | 12-18 | 37 | | 10-16 |
| 12 | | 19-25 | 38 | | 17-23 |
| 13 | | 26-1 | 39 | | 24-30 |
| 14 | April | 2-8 | 40 | October | 1-7 |
| 15 | | 9-15 | 41 | | 8-14 |
| 16 | | 16-22 | 42 | | 15-21 |
| 17 | | 23-29 | 43 | | 22-28 |
| 18 | | 30-6 | 44 | | 29-4 |
| 19 | May | 7-19 | 45 | November | 5-11 |
| 20 | | 14-20 | 46 | | 12-18 |
| 21 | | 21-27 | 47 | | 19-25 |
| 22 | | 28-3 | 48 | | 26-2 |
| 23 | June | 4-10 | 49 | December | 3-9 |
| 24 | | 11-17 | 50 | | 10-16 |
| 25 | | 18-24 | 51 | | 17-23 |
| 26 | | 25-1 | 52 | | 24-31(*) |

* In leap year the week 9 will be 26th February to 4th March (8 days)

(*) Last week have 8 days, 24 to 31 December

APPENDIX - II

| Number | Variety |
|---|---|
| 1 | Balankotta-1 |
| 2 | Balankotta-2 |
| 3 | Cheriya Kaniyakadan |
| 4 | Chumala |
| 5 | Kalluvally-1 |
| 6 | Kalluvally-2 |
| 7 | Kalluvally-3 |
| 8 | Kaniyakadan |
| 9 | Karivilanchy |
| 10 | Karimunda-1 |
| 11 | Karimunda-2 |
| 12 | Karimunda-3 |
| 13 | Karivally |
| 14 | Kottanadan |
| 15 | Kumbhakody |
| 16 | Kuthiravally |
| 17 | Kuthiravally-AR |
| 18 | Munda |
| 19 | Narayakodi |
| 20 | Palulauta |
| 21 | Perumkodi |
| 22 | Perumunda |
| 23 | Sallia |
| 24 | Taliparamba-I |
| 25 | Taliparamba-II |
| 26 | Taliparamba-III |
| 27 | Taliparamba-IV |
| 28 | Valli |
| 29 | Valiyakodi |

# INFLUENCE OF WEATHER PARAMETERS ON THE YIELD OF BLACK PEPPER

By

DESSY MABEL

**ABSTRACT OF THE THESIS**

Submitted in partial fulfilment of the
requirement for the degree

**Master of Science (Agricultural Statistics)**

Faculty of Agriculture
Kerala Agricultural University

Department of Agricultural Statistics
COLLEGE OF HORTICULTURE
Vellanikkara, Trichur

1990

ABSTRACT

Influence of weather parameters on the yield of black pepper was studied utilising the data on yield of 29 varieties of pepper (Pipper nigrum) and maximum temperature, minimum temperature, relative humidity, rainfall and number of rainy days recorded from 1963-64 to 1979-80 at The Pepper Research Station, Kerala Agricultural University, Panniyoor, in the Cannanore District of Kerala.

Averages/totals of weather elements for standard weeks as well as for fortnights during the critical period of crop growth viz. from April 9 to August 12 were determined. Correlation coefficients of all the weather elements of standard weeks and fortnights with annual yield when represented in correlograms revealed, wide variations in response of different varieties to changes in climatic factors among the 29 varieties. In other words there was definite evidence of genotype - environment interaction.

Forcasting models, based on weekly as well as fortnightly weather elements were estimated for each of the 29 varieties of black pepper by two stage linear regression technique.

First stage models were estimated by multiple linear regression and the second stage models were estimated with the estimates of yield from first stage models as explanatory variables by step-wise regression technique.

The forecasting models utilising weekly climatic data had higher predictability compared to that utilising fortnightly data. All the final forecasting models with weekly data had predictability of 98% and above. More over the first stage models, from weekly data, could also be used to forecast yield of all varieties of black pepper with remarkable accuracy.