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Assessment of impact of Climate change on Rice production in Faizabad (U.P.)

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ABSTRACT
The effects of weather variables have been studied on rice yield in Faizabad district of U.P. using time series data. The weekly data on weather variable covering the period from 1990-91 to 2009-10 for maximum temperature, minimum temperature, relative humidity, wind velocity, sunshine hour, rainfall and number of rainy days have been utilized for the proposed study. The pattern of weather variables in different crop growth phases have also been worked out. The results revealed that the maximum and minimum temperature has played important role for yield in every phase and relative humidity is showing the mixed pattern. Rainfall of first phase is most important for the yield and deficiency of rainfall in early growth phase adversely affects the yield. Similar results were indicated by graphically representation for number of rainy days. For the years, where yield is at maximum level the early growth phase of the crop has plenty of rainfall and less wind velocity in maturity phase. No specific trend of the crop yield has been found with the pattern of sunshine hours during different phases of crop growth.
***Key words**: Weather variables, time series data, rice yield, Pattern of weather variables.*

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INTRODUCTION

Rice is the most important crop in Asia, which is home to three - fifths of humanity. Rice is the second most cultivated cereal after wheat. It provides 20% of the per capita energy, and 13% of the protein consumed worldwide [7]. In India, more than half of the annual rice crop continues to be grown during the summer monsoon season (kharif), despite increased dry-season harvests made possible by expanded irrigation.

Uttar Pradesh is the largest state in country, comprised in two physiographic regions viz. Gangetic plains and southern plateau. From cultivation view point gangetic plains cover major portion of the state. Rice is the major crop in Uttar Pradesh and is grown in about 5.90 mha which comprises of 13.5% of total rice in India. Uttar Pradesh has favourable and suitable climate, vast areas of fertile soils, sunshine and adequate water resources. The cropping intensity is 153%. The state ranks 3rd in the country in production of rice.

Agriculture in India and in the entire world is mostly dependent on the persisting weather condition. The alternation in global warming has dramatically affected agriculture and its productivity [1, 2]. The increase in temperature has significantly led to change in the agricultural zones and shift in the growing season. On the other hand, the change in rainfall pattern is the serious threat to the agriculture, which in turn affects the country's economy and food security [4-6]. The delayed or inadequate monsoon also cause influence on the sale of agriculture inputs such as fertilizers, agrochemicals etc. Some of the areas in India receive more than normal rainfall while some of the areas receive below the normal rainfall. The various studies show the overall loss in the crop production in the country in the last few years is due to the anticipated rise in the temperature. It is expected that in the near future India is going to face the challenges that includes unwanted pressure from the growing population and changing scenario of world trade in agriculture. Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall, but also by shifts in the timing of the rainfall. Higher temperatures reduce the total duration of a crop cycle, leading to a lower yield per unit area, especially for India's wheat and paddy crops. Soil erosion, increased numbers of pests and weeds brought by climate change will also affect

agriculture in India. For instance, the amount of moisture in the soil will be affected by changes in factors such as rainfall, runoff and evaporation. Some species of agricultural crops will be adversely affected by higher temperatures, increased weeds and harmful insects. It is also possible that global warming will lead to global food shortages [8, 10, 12, 13].

[14, 15, 11, 3] studied the sensitivity of rice to high temperature varies with growth phase, an increase in day/night temperature. The growth of a rice plant can be broadly divided into three phases: vegetative, reproductive and ripening or grain filling [16, 9].

MATERIAL AND METHODS

Study region, methodology and yield response of rice

The study has been conducted for Faizabad district of Eastern Uttar Pradesh, which is situated between 260 47' N latitude and 820 12' E longitudes. It lies in the Eastern Plain Zone (EPZ) of Uttar Pradesh. It has an annual rainfall of about 1002 mm and is liberally sourced by the Sarju (Ghaghra) river and its tributaries.

The weather variables affect the crop differentially during different phases of its growth period. The study has been conducted for Faizabad district of Eastern Uttar Pradesh, India. Time series data on yield for rice crop of Faizabad district of Uttar Pradesh for 20 years (1990-91 to 2009-10) have been collected from Directorate of Agricultural Statistics and Crop Insurance, Govt.of Uttar Pradesh. Weekly weather data (1990-91 to 2009-10) on the weather variables of Faizabad district of Uttar Pradesh during the different growth phases of rice crop have been obtained from the Department of Agro Meteorology, N.D. U. A. & T. Kumarganj, Faizabad. The rice crop data have been collected up to the 21 weeks of the crop cultivation which include 25th SMW to 45th SMW. The data on seven weather variables viz. Minimum Temperature, Maximum Temperature, Relative Humidity, Rainfall, Wind-velocity, Number of rainy days and Sun-shine (hr) have been used in the study of rice crop.

The different crop growth phases are early growth phase which comprises of early 5 weeks of growing season covering June 18 (25th SMW) to July 22 (29th SMW) includes period from sowing to emergence and initial growth phase of the crop., grand growth phase which covers 13 weeks from July 16 (29th SMW) to October 14(41th SMW) which includes active lag vegetative and reproductive growth periods and maturity phase which covers 4 weeks from October 15 (42th SMW) to November 11(45th SMW) which includes the ripening stage of crop.

Study of weather pattern vis-a-vis rice yield

The pattern of weather variables have been worked out in different crop growth phases. The average of each weather variable in different crop growth phases has been worked out as follows:

$$\overline{X}_i = \sum_{w=1}^{n} X_{iw} \Big/ n$$

where n is number of weeks in crop growth phases , $\overline{X}_i$ is average of ith weather variable and X_{iw} is the value of ith weather variable in wth week.

Let $\overline{G}_i$ be the average value of a weather variable in ith crop growth phase based on 20 years data, which is considered as normal value for that weather variable. The deviation in percentage from their normal value ($\overline{G}_i$) have been worked as

$$d_i = \frac{\overline{G}_i - \overline{X}_i}{\overline{G}_i} \times 100$$

These deviations have been plotted against years in two dimensional space along with rice yield over years to study the weather pattern vis-a-vis rice yield in different crop growth phases.

RESULTS AND DISCUSSION

Weather is a critical factor influencing the production of crops in any region. The weather factors count more than others because of their direct and indirect effects on crops. The results are presented and discussed in the following section.

Pattern of weather variables in Different Growth Phase of Rice Crop

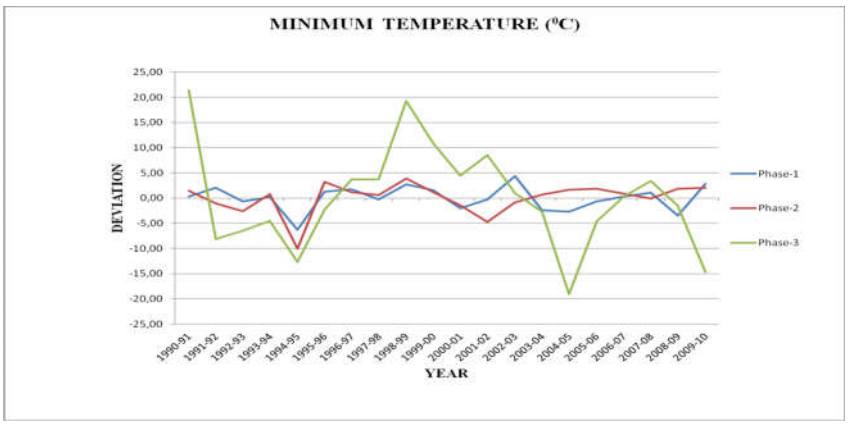

Fig 1

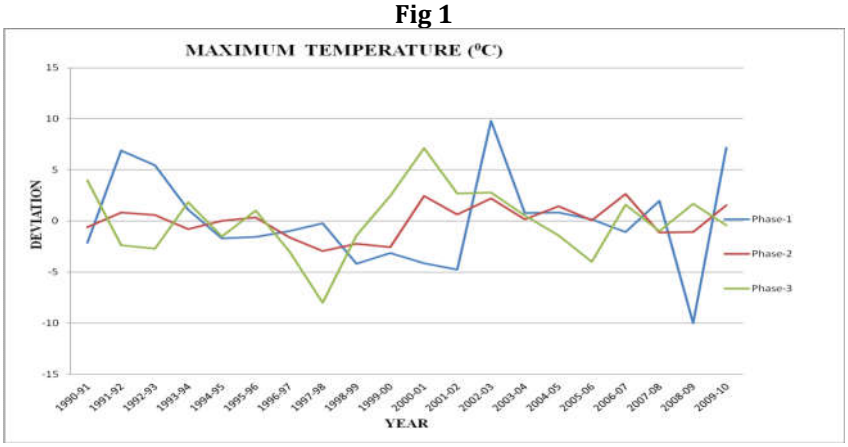

Fig 2

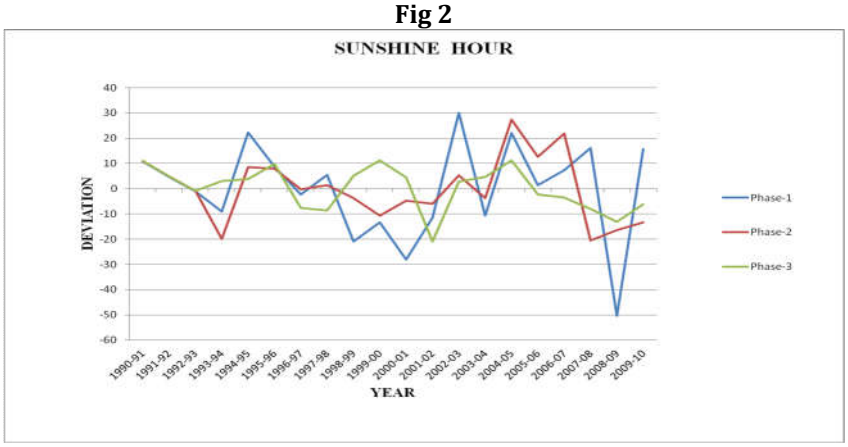

Fig 3

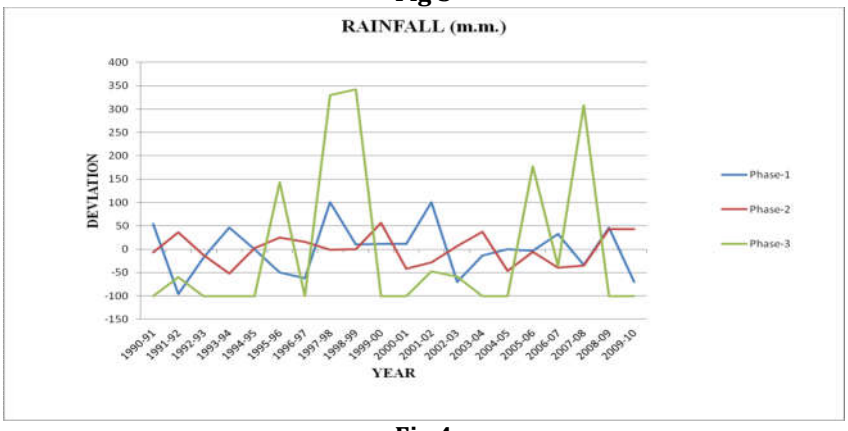

Fig 4

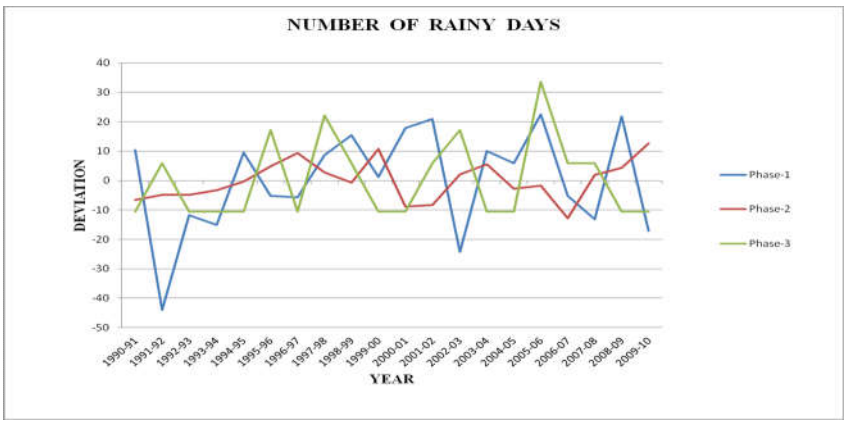

Fig 5

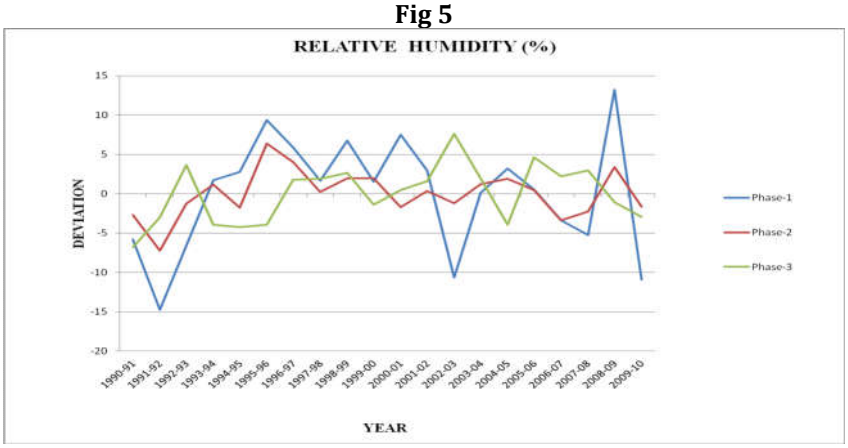

Fig 6

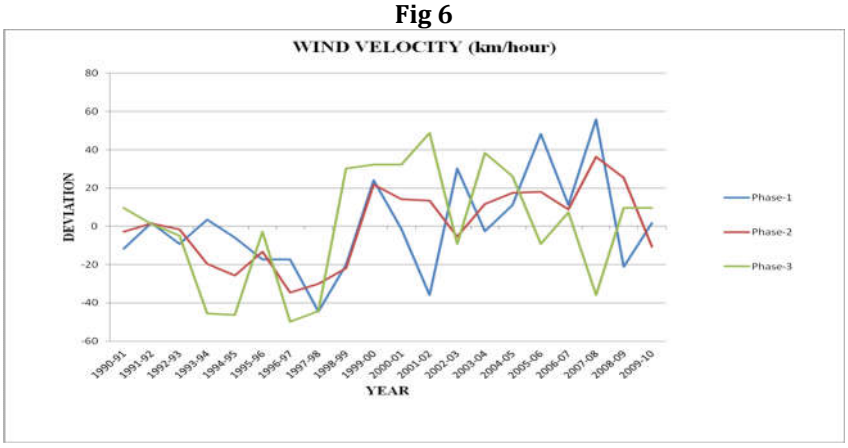

Fig 7

The graphs reflects the pattern of weather variables in different phases. It can be observe from fig 1 that there has been much fluctuation in minimum temperature during phase-3 followed by phase-2 and 1.Fig 2 to fig 5 shows that the weather variables such as maximum temperature, sunshine hours, rainfall and number of rainy days have maximum fluctuation in phase -1 followed by phase-3 and 2. It also observed from fig 3.1.6 that relative humidity has been much fluctuation during phase-1 followed by phase-2 and 3 and fig 7 shows that the wind velocity has maximum fluctuation during phase-3 followed by phase-1 and phase-2.

The Relationship of Rice Crop Yield with Pattern of Weather Variables in Different Phase of Crop Growth:

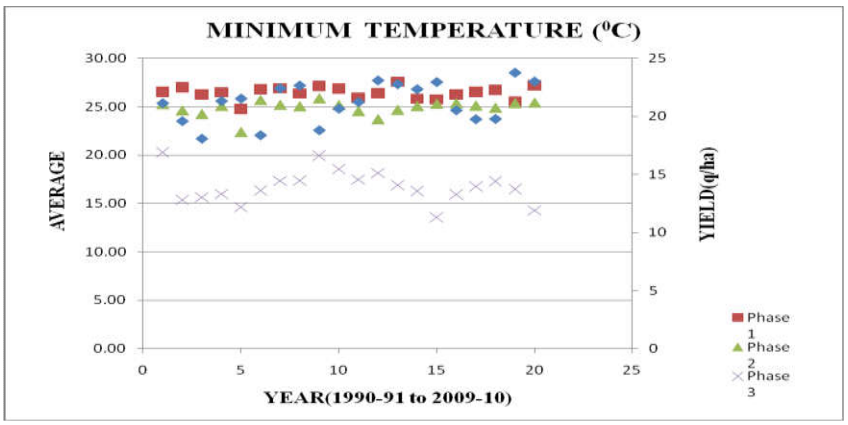

Fig 8

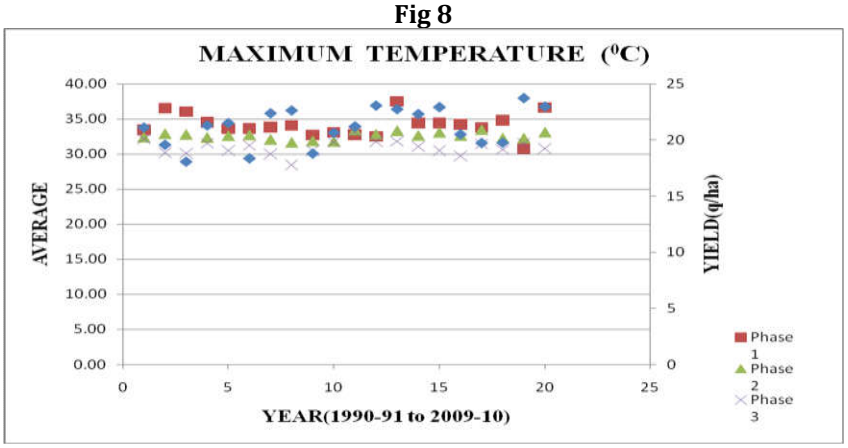

Fig 9

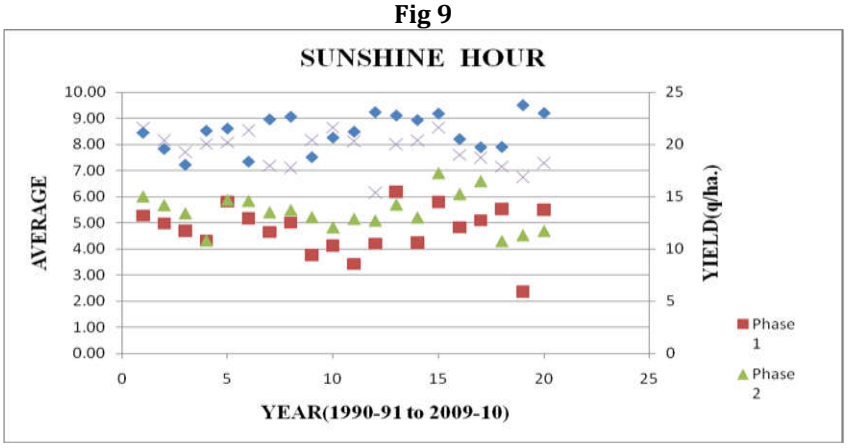

Fig 10

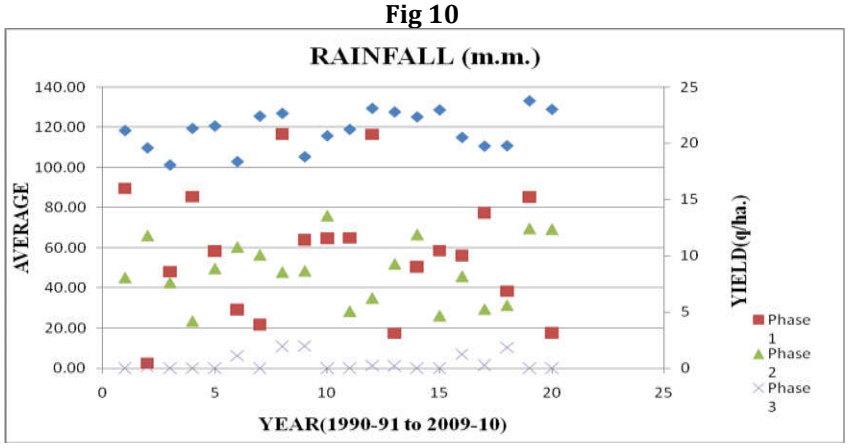

Fig 11

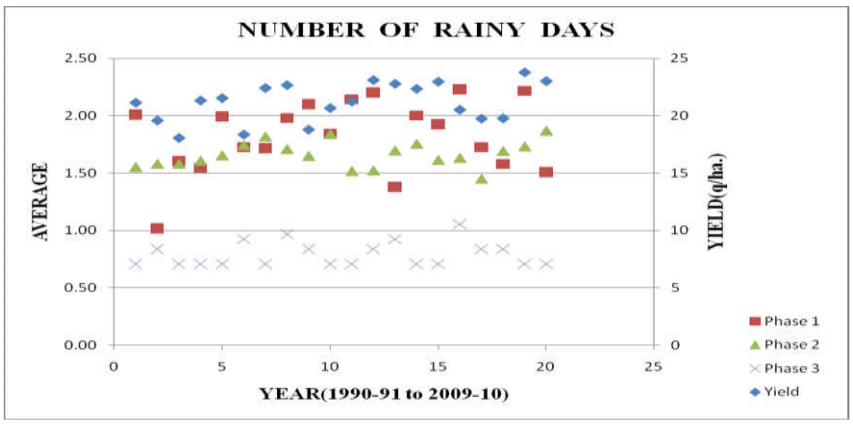

Fig 12

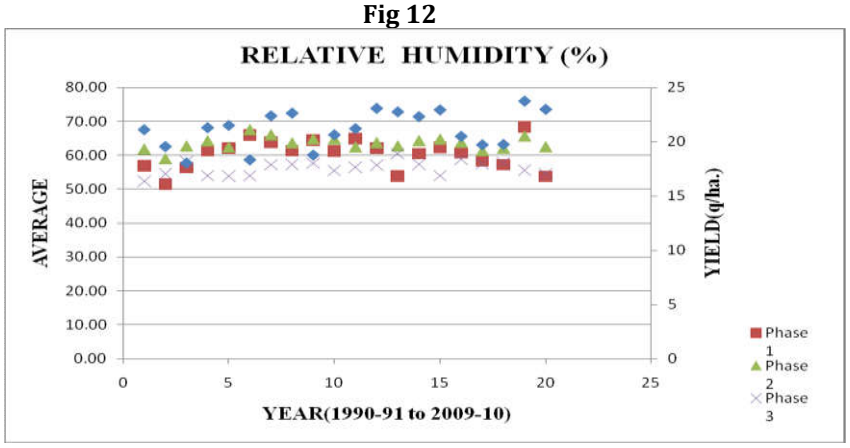

Fig13

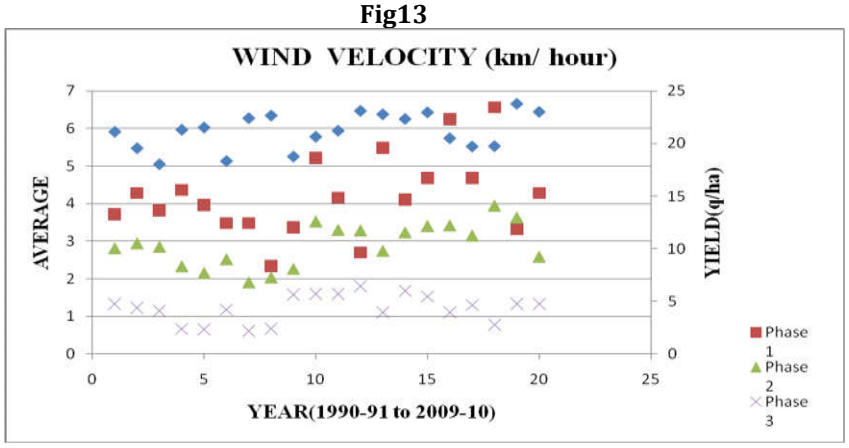

Fig 14

It can be observed from the Fig 7 to 14 that the minimum and maximum temperature has played important role for yield in every phase. The years 1998-99, 2002-03 and 2009-10 where the yield is at maximum level the minimum temperature in phase 1 is higher than phase 2 and 3. As far as maximum temperature is concerned it is not indicating and definite pattern. For the year 2009-10 where the yield is at maximum level the maximum temperature of phase 2 and 3 are almost at the same level. Relative humidity is showing the mixed pattern as in the case of maximum temperature.

The graph of rainfall indicates that, rainfall of first phase is most important for yield. It is also obvious from the graphs that deficient rainfall in phase-2 is being compensated by the rainfall of the phase-1. Such pattern is seen for years 1998-99, 2002-03 and 2009-10.

Deficiency of rainfall in phase-1 adversely affects the yield. Similar results are indicated by graph for number of rainy days. For the years, where yield is at maximum level the phase-1 of the crop has plenty of rainfall and less wind velocity in phase-3. No specific trend of the crop yield has been found with the pattern of sunshine hours during different phases of crop growth.

CONCLUSION

The graphical study reveals the mixed results. It seems from the graph that technological development and weather parameters like- temperature, humidity, sunshine hours, wind velocity and rainfall are mixed up. However graph shows that rainfall in first phase and wind velocity in third phase increases the yield. The data of the years 1998, 2002 and 2009 have good yield. It is also obvious that good rainfall in first phase may compensate the deficiency in rainfall of the second phase. The converse is not reflected by graphical trends.

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