

Climate –Fruit Crop Juxtaposition

In nutshell, amongst all the studied crops, Pear productivity showed maximum sensitivity to climatic variations during all phenological stages (66.5%, 55.2%, 55.2%). For Apple and Walnut crop significant correlation was observed and for flowering and fruit setting i.e., (57.8% and 47.6%) and (29.2% and 39.1%) respectively. For Apricot (81.2%, 84.8%) during pre-flowering and flowering, Almond (32.5% and 36%) and Grapes (41.2% and 64%) during pre-flowering and fruit setting. For Plum crop only one climate variable i.e., mean maximum temperature impacts 23.1% during the fruit setting and development stage. With respect to individual crops, the observed variations in productivity for Pear crop from 1990-2019 is explained by the variations in climatic parameters to the extent of 66.5% during pre-flowering stage, 55.2% during the flowering stage and 55.2% during the fruit setting and development stage.

Conclusion

Crop Variations:

Apricot and Almond crops showed statistically significant increase in productivity as per Mann Kendal test results.

Productivity of Apple, Plum, Pear, Walnut and Grapes did not show any statistically significant changes from 1990-2016 as per results of Mann Kendall Test.

Productivity of Apricot showed a significant increase from 2001 to 2015. The minimum value (0.06 MT/ha) of productivity was observed in 2001 while maximum (3.15 MT/ha) for 2003 with slight ups and down till 2011 then gradual increase till 2015.

Productivity of Almond reduced significantly from 2001 to 2015 i.e., 0.64 MT/ha and 0.14 MT/ha respectively.

Climatic Variations:

Higher variability in temperature and rainfall parameters observed during **fruit setting period then pre-flowering period** as compared to **flowering** from 1990 to 2019.

During the **pre- flowering season** i.e. between November–February, the average minimum temperature and total rainfall registered an inclining trend at a rate of -0.49°C and -14.17 respectively per year between 1990-2019.

During the **flowering season** i.e. March to April, the average maximum, minimum and diurnal temperature increased by 2.12°C , 0.02°C and 1.69°C per year respectively.

The average maximum and minimum temperature during **fruit setting stage** i.e. between May–August, registered a decreasing trend at a rate of -0.14°C and -0.75°C per year respectively between 1990-2019

However, none of the climatic variable registered a significant impact on the above mentioned phenological stages.

Climate Crop Juxtaposition

Highly significant correlation between climate variability and productivity was observed during the pre-flowering, flowering and fruit setting and development stages, with a predominant impact on the productivity of Apple, Plum, Pear, Apricot, Almond, Walnut and Grapes.

Amongst all temperate fruit crops, **Pear** found to be most vulnerable to impact of climatic variability at all three phenological stages while **Plum** was least vulnerable.



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Impact of Climate Change in Horticulture Sector of District Kinnaur, Himachal Pradesh



State Centre on Climate Change

Under the aegis of
**Himachal Pradesh Council for Science,
Technology & Environment (HIMCOSTE) H.P.**

Introduction

Horticulture is a vibrant sister sector of Agriculture, distinguished by scale of production and commercialization and assumes a pivotal role to foster food, economic and nutritional security globally. India is the second largest contributor to world's horticulture produce, where it accounted for a record 307.16 MT of production in 2017-18. Nonetheless, this high contributing sector has a wider exposure to climate change when compared to its close associate Agriculture sector, but with a relatively smaller carbon footprint. In India, 8.71 per cent of carbon emissions came from the Agriculture, Food and Land-use in 2013 however, the carbon sequestration quotient from a mixture of perennial horticulture crops such as tree fruits, tree nuts, vine fruits and seasonal vegetables, herbs offering carbon storage above the ground, net offs the sector's carbon footprint.

The Himalayan ecosystem is positioned at high vulnerability with respect to pressing perils of looming climate change. While heightened focus of recent research and discussions have been around glacial retreat and its impact on downstream water discharge, nevertheless there are growing evidences for the potential cascading impact of climate change in the Himalayas on all connected and satellite regions. The fragile Himalayan ecosystem, owing to its geological history and structural rock set-up, is fast approaching a state of disequilibrium with apparent changes in its resources and environment.

A status study was conducted with a view to ascertain the impact of climate change on Horticultural sector in district Kinnaur of Himachal Pradesh. Seasonal trends on climatic variables of minimum, maximum and diurnal temperatures and rainfall patterns were conjugated with a standardized anomaly index and a multivariate regression analysis was conducted to establish the climate and crop yield relationship during the phenological stages of *pre-flowering, flowering and fruit setting and development*.

Methodology

To understand the impact of climate change variable of temperature and precipitation (rainfall) vis-à-vis parameters of horticulture productivity, the following statistical measures were employed.

- Trend Analysis
- Standardized Anomaly Index (SAI)
- Multivariate Linear Regression Model

Climate Trends

As per the analysis, the average minimum temperature and total rainfall registered an inclining trend at a rate of -0.49°C and -14.17 respectively per year between 1990-2019 (as exhibited by the Sen's slope) during the *pre-flowering season* i.e. between November – February.

During the *flowering season* i.e. March to April the average maximum, minimum and diurnal temperature increased by 2.12°C , 0.02°C and 1.69°C per year respectively. The average maximum and minimum temperature during *fruit setting stage* i.e. between May–August registered a decreasing trend at a rate of -0.14°C and -0.75°C per year respectively between 1990-2019. However, all the climatic variables did not exhibit any significant variation during the pre-flowering, flowering and fruit setting developmental stages. Figure 1 illustrates the trend variation in climatic parameter during the three phenological stages.

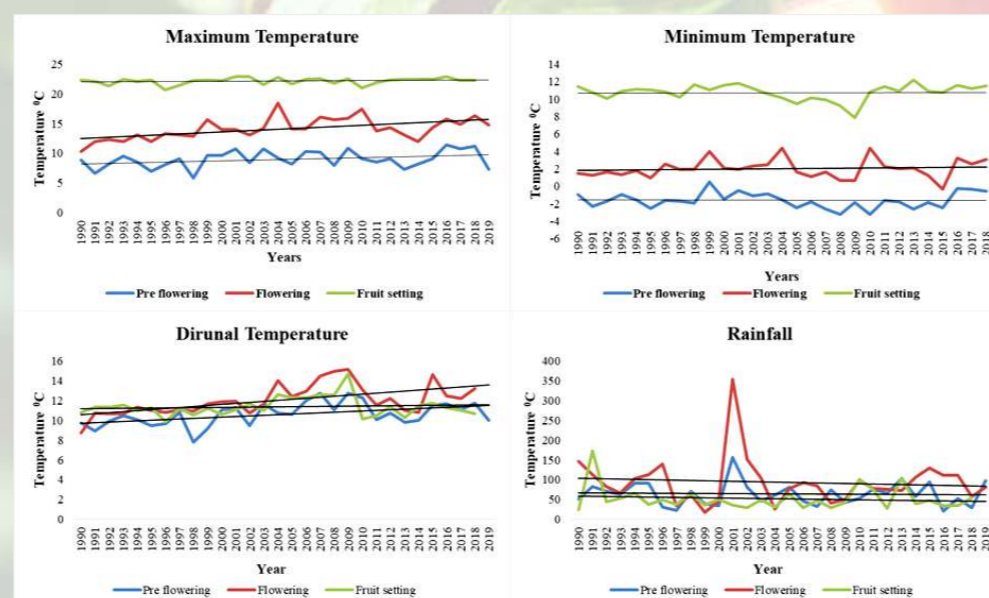


Figure 1. Variations in Climatic Parameters- Minimum T, Maximum T, Diurnal T and Rainfall during *pre-flowering, flowering, and fruit setting stages (1990-2019), District Kinnaur, HP*

Fruit Crop productivity

Acreage under apple cultivation increased from 6604 ha in 2001 to 11164 ha in 2015 (an increase of 69 per cent) and the production surged from 18,808 MT to 75,202 MT (2001-2015). Nonetheless, productivity of Apple did not register any statistically significant variations, with minimum productivity of 2.85 MT/ha in 2001 and maximum of 6.74 MT/ha in 2015. The acreage of Plum crop was 7 ha in year 2001 but in 2002 it abruptly increased to 67 ha after that it showed gradual increase in acreage. Production showed irregular trend with minimum value (1 MT) for year 2007 and maximum (13 MT) for 2003. The productivity showed intermittent results with minimum 0.07 MT/ha for 2002 and maximum 1.63 MT/ha for 2003. However, area, production and productivity did not register any significant variation.

Pear is also an important fruit crop in Kinnaur district. The acreage of pear gradually increased from year 2001 to 2015 while the production was higher (84 MT) for year 2009 then goes down. Productivity of pear for Kinnaur district showed significant results as it was maximum for year 2001 and minimum for 2014. Productivity is minimum for 2002 i.e. 0.07 MT/ha and maximum for 2003 i.e., 1.63 MT/ha. Statistically, productivity of pear is decreased.

The acreage of Apricot crop showed a constant variation from 2001 to 2007 and then 2008 to 2015. Overall increase was observed in acreage from 251 ha to 336 ha. The production of apricot showed a decreasing trend from 2002 to 2015 i.e., from 623 MT to 381 MT respectively. Productivity of Apricot showed a visual increase from 2001 to 2015. The minimum value (0.06 MT/ha) of productivity was observed in 2001 while maximum (3.15 MT/ha) for 2003. In comparison to 2001, the productivity of apricot significantly decreased.

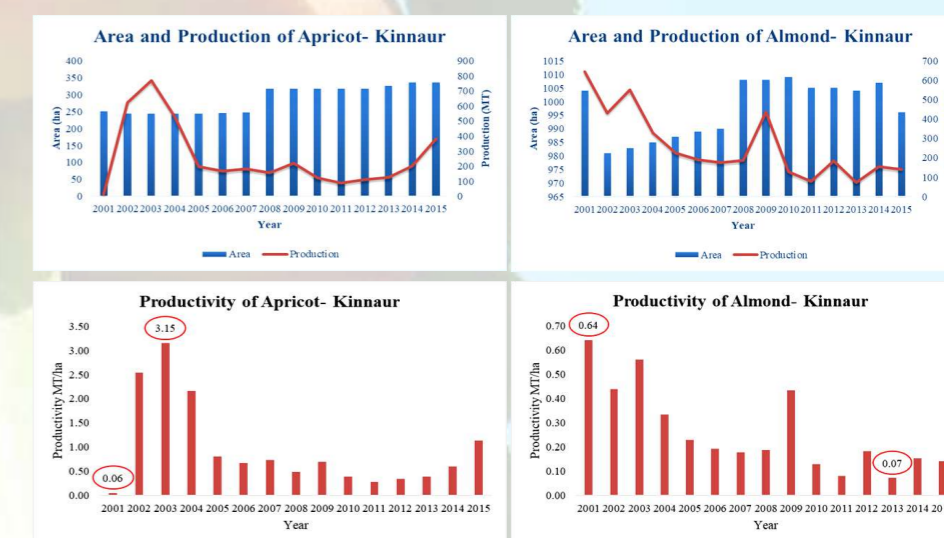


Figure 2. Variations in Annual Acreage, Production, and Productivity-Apricot and Almond (2001-2015), District Kinnaur, HP

The acreage of Almond was maximum (1004 ha) in 2001 which decreased to 981 ha in 2002. After 2002, acreage showed a gradual increase till 2010 and after that, intermittent decrease to 996 ha in 2015. Production of Almond showed a decreasing trend from 645 MT to 141 MT. Productivity of almond reduced significantly from 2001 to 2015 i.e., 0.64 MT/ha and 0.14 MT/ha respectively (Figure 2).

Meanwhile, the acreage of other fruits like Walnut and Grapes increases from 2001 to 2015. For Walnut, acreage was maximum for 2008 and 2009 and then decreased in 2015 while for Grapes acreage was almost constant till 2007 then increased to 28 ha and remains constant till 2015. Production of Walnut showed an irregular trend with overall decrease from 114 MT to 51 MT (2001 and 2015 respectively). While, production of Grapes showed increasing trend. Productivity of both the crops showed an intermittent result but none of these showed a significant variations.