Indian Journal of Ecology (2024) 51(5): 1085-1088
DOI: https://doi.org/10.55362/IJE/2024/4357

Manuscript Number: 4357
NAAS Rating: 5.38

Impact of Western Disturbances on Stone Fruits in Mid Hill Zone of Himachal Pradesh

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***Abstract*:** The study on impact of western disturbances on stone fruits grown in mid hill zone of Himachal Pradesh" was done at Dr. YS Parmar University of Horticulture and Forestry, Nauni.The western disturbances (WD) data was collected for the period 1984-2022. The arrival and withdrawal of WD indicated that during the period of 38 years the WD arrived during October and withdrawal during May in Solan district of Himachal Pradesh. The WD duration and amount of rainfall received was decreasing at 0.29 Julian days/year and 1.65 mm/year but, the number of WD was increasing at a rate of 0.12 JD/year which indicated that the frequency, distribution and intensity of WD was increasing over time in mid hills of Himachal Pradesh. The regression relationship was developed between the number of WD and productivity at development and maturity stages of plum and apricot crops. The results depicted positive relationship between number of western disturbance and productivity at developmental stages with coefficient of determination (R^2: 0.58 and R^2: 0.51) whereas showed negative relationship at maturity stage of selected crop.

***Keywords*:** Frequency, Western disturbance, Monthly variation, Regression, Crop

Western disturbances (WD) are cyclonic circulation/ trough in the mid and lower tropospheric levels or as a low-pressure area occurs in mid-latitude westerlies and originates over the mediterranean Sea, Caspian Sea and Black Sea and moves eastwards across north India. These are the most fundamental level, synoptic-scale vortical perturbations embedded in the subtropical westerly jet stream (Dimri et al 2016) and are most common during December to March, bring rain to the Western Himalayas as well as to the surrounding areas of north India, Pakistan and the Tibetan Plateau and also associated with weather hazards such as heavy snowfall, hailstorms, fog, cloudbursts, avalanches, frost, and cold waves (Hunt et al, 2024). The erratic and increasing pattern of rainfall in Karnataka district may lead to the flash floods and at times drought situations (Bharath and Venkatesh 2022).

Agarwal et al (2021) also analysed that in early 1950s, winter and monsoon rainfall was showing decreasing trend whereas the summer and post-monsoon was showing an increasing trend resulting into a westward shift, more variable and declining rainfall over the country. Himachal Pradesh is situated in the western Himalayas and is divided by altitudinal ranges of 350 m to 6975 m above sea level due to a complex geographical feature which results in a variety of climatic patterns, from hot and humid tropical climates in the south to frigid, alpine, and glacial climates in the eastern and northern mountain ranges. According to the report of Himachal Pradesh State Action Plan on Climate Change (2012) projects states that during the last 25 years, there has been a 40% decrease in rainfall. Kumar et al (2019) highlights the vulnerability of stone fruit cultivation in the face of such climatic variability. The study underlines the importance of understanding the specific impacts of western disturbances on stone fruit crops to devise effective adaptations and mitigation strategies.

Western disturbances exert a notable influence on stone fruit cultivation in the mid-hill zone of Himachal Pradesh, necessitating a comprehensive understanding of their impacts and the implementation of suitable measures to ensure the sustainability of agricultural practices. The main objective of the study is to investigate how WD influences phenological stages (flowering, fruit set, ripening) of stone fruit crops in the mid-hill zone of Himachal Pradesh.

MATERIAL AND METHODS

Experimental site: The study was conducted at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni-Solan (30°2240– 33°1240N and 75°4755-79°0420E) and 350 m to 6,816 m amsl during 2021-2023.

Data collection: The daily rainfall and rainy days data of 38 years (1984-2022) was collected from Agromet observatory, Department of Environmental Science, Nauni Solan whereas the data on area and production of stone fruit crops *viz*., Plum and Apricot for last 30 years (1990-2020) for Solan district was collected from the Department of Horticulture, Govt. of Himachal Pradesh.

Analysis of Western Disturbances

Duration and Frequency of western disturbances: The rainfall 2.5mm/day and more was considered as a WD spell. If the spell was continued for one day than WD spell is considered for 1 day. If the spell was continued for two days than WD spell is considered for 2 days and so on if the spell was continued for five days, than WD spell is considered for 5 days. The frequency of western disturbances was considered as the number of WD occurred during a month, season or year. Gill et al (2021) calculated the frequency of occurrence of WD duration for each month separately.

Frequency = Total rainfall / Total numbers of WD

Linear regression analysis: Linear regression analysis is a parametric model and one of the most commonly used methods to describe a trend in a data series and develops a relationship between two variables by fitting a linear equation to the observed data. The data is first checked whether there is relationship between the variables of interest or not. This can be done by using the scatter plot. The linear regression model is generally described by the following equation:

$Y = aX + b$

Y= dependent variable, X= independent variable, a= slope of line, b= intercept constant.

RESULTS AND DISCUSSION

Arrival, withdrawal and duration of western disturbances: The date of arrival of WD was decreasing (advancing) at a rate of 0.19 Julian days/year. Out of 37 years the arrival was below the normal for 21 years and above the normal during 16 years, it means that the WD arrival was early in 21 years and getting late during 16 years in the study area (Fig. 1) and the withdrawal date was increasing (delaying) at a rate of 0.11 Julian days/year (Fig. 2). Out of 37 years, 12 years showed the withdrawal below and remaining 25 years above the normal date of withdrawal of WD. The withdrawal of western disturbances was advanced in 12 years and delayed in 25 years in the study area. Dadial et al (2024) also studied the different behavioural characteristics of western disturbances (WD) like onset, withdrawal, durations and amount of rainfall in WD in Solan district of Himachal Pradesh. The annual duration of WD was decreasing at a rate of 0.29 Julian days/year, means decreasing at about 8 hours/year (Fig. 3).

Annual variation of number of WD and associated rainfall : The highest number of WD had been observed in one day duration (405) followed by two days duration (234) up to more than five days duration in the descending order whereas the associated rainfall was observed highest (4692.1 mm) for the WD of two days duration followed by one day duration and three days duration whereas lowest for the WD of more than five days duration. The frequency of WD spell (61.8 mm) was received highest in five days WD spell followed by four days WD spell (61.1mm). Deviation from mean value was highest for two days duration and lowest for more than five days duration whereas coefficient of variation was calculated highest for more than five days duration and lowest for one day duration. The positive slope and trend were observed increasing for the WD of one to four days duration whereas decreasing for five and more than five days duration (Table 1).

The variation in annual number of WD was increasing at a rate of 0.12JD/year (Fig. 4) whereas, annual rainfall received from WD was decreasing at a rate of 1.66 mm per year (Fig. 5). Similar results were obtained by Jaswal et al (2015) indicated that seasonal and annual trends in rainfall over Himachal Pradesh for 37 stations from 1951 to 2015 significantly decreasing by 4.58 mm/year. All the 37 stations in Himachal Pradesh were not showing an increasing trend in

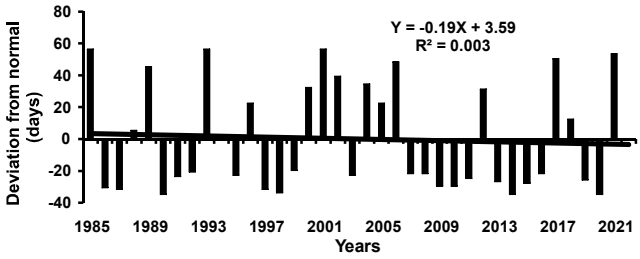

Fig. 1. Annual deviation (days) of WD from normal date of arrival

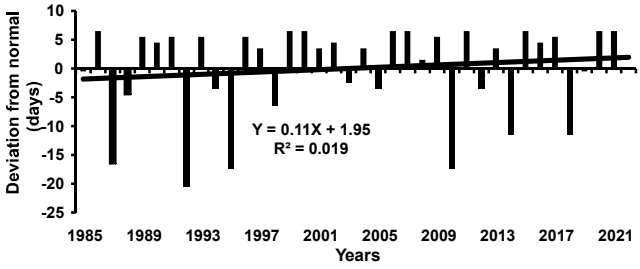

Fig. 2. Annual deviation (days) of WD from normal date of withdrawal

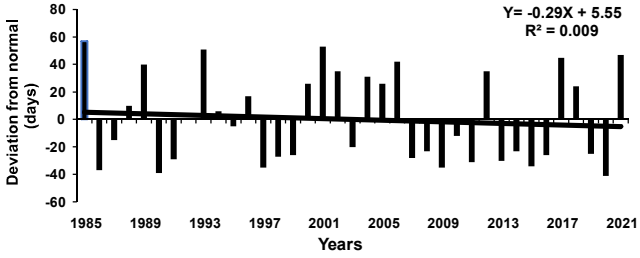

Fig. 3. Deviation in day from normal duration of western disturbances

Table 1. Annual variation in WD of different durations from 1984-2022

Durations (Days)	Number of WD	Rainfall (mm)	Mean	SD (σ)	CV (%)	Slope (Year)	Trend	Frequency
1	405	3321.5	44.8	81.01	55.3	0.11	↑	8.2
2	234	4692.1	67.7	114.44	59.1	0.06	↑	20.0
3	91	3309.2	71.9	80.71	89.1	0.16	↑	36.3
4	39	2385.3	65.7	58.18	113.0	0.68	↑	61.1
5	10	618.6	41.8	15.09	277.6	-0.36	↓	61.8
>5	6	358.3	25.3	8.74	290.4	-0.50	↓	59.7

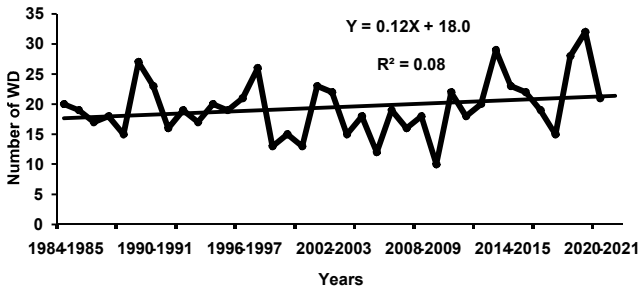

Fig. 4. Annual variation in number of western disturbances

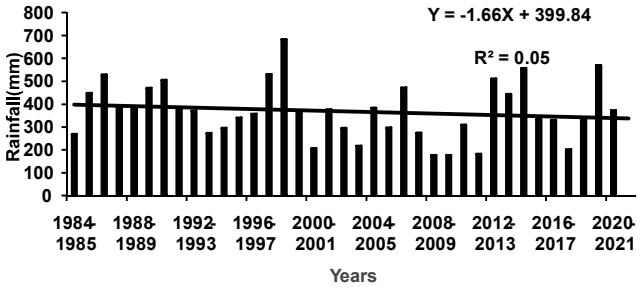

Fig. 5. Annual variation of rainfall received through western disturbances

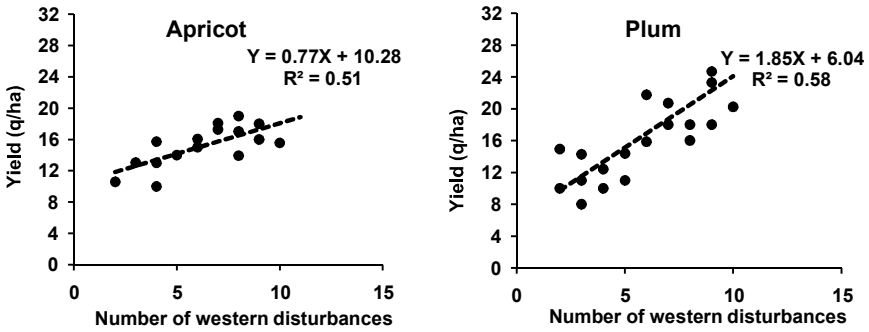

Fig. 6. Effect of number of WD on crop yield occurred at development stage

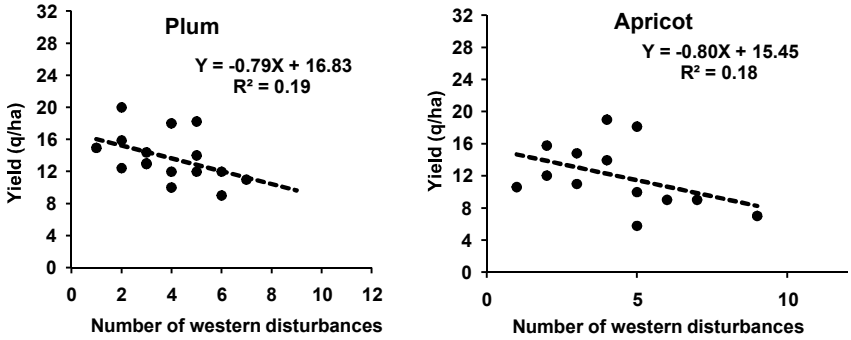

Fig. 7. Effect of number of WD on crop yield occurred at maturity stage

annual rainfall. Harshavardhan et al (2020) investigated the spatiotemporal trends in rainfall in Krishna River Basin in India from 1965 to 2012 and observed that annual and post-monsoon precipitation exhibited a significant negative trend in magnitude from the normal.

Regression relationship of number of WD with productivity of stone fruit crops: The linear regression model was developed between number of western disturbance and productivity of Plum and Apricot crop at development and reproductive stage. At development stage

both the crops showed the positive relationship with variation of 58 and 51 percent (Fig. 6) whereas showed negative relationship at reproductive stage with variation of 19 and 18 per cent (Fig. 7). The results inferred that the increase in the number of western disturbances caused detrimental effects on crop yield at a rate of -0.79 and -0.80 quintal per number of WD during reproductive to harvesting stage. The occurrence of heavy rainfall accompanied with high wind speed due to western disturbances at flowering stage will be washed out pollen from the stigma of the flower, resulting in poor or no fruit setting. Similarly, at the time of maturity, it leads to fruit dropping or poor quality of fruit. Mehta et al (2022) highlighted that erratic rainfall patterns led to a shorter cropping calendar, affecting agricultural practices. Over the past three decades, farmers have observed a mismatch in rainfall, with insufficient rain during crucial periods and excessive rain when it is not needed. Dadial et al (2024) reported that rainfall at development stage showed beneficial effects on wheat, barley, and peach crops whereas, rainfall during the months of April and May impacts the harvesting and threshing of wheat crop thus decreases the quality and quantity of crop. The hailstorm events in the month of April and May reduced the yield of peach crop in mid hill zone of Himachal Pradesh.

CONCLUSIONS

The annual duration of western disturbance and amount of rainfall received from October to May depicted decreasing trend. While the western disturbance spells of day 1 to 4 showed increasing trend whereas day 5 and >5 spells showed decreasing trend thus indicated that the frequency, distribution of WD was increasing over time in mid hills of Himachal Pradesh. The regression model developed between the number of WD and productivity depicted positive relationship at developmental stages while showed negative relationship at maturity stage of selected crops. Hence, farmers should reschedule the plant protection measures and irrigation activity according to the weather forecast during critical growth stages. The farmers should sow the crops at optimum date and avoid late sowing of crops to prevent the maturity and harvesting stages from coinciding with peak WD activities. With a decline in the amount of rainfall during WDs, ensure proper irrigation management to supplement water needs during critical growth stages. Rainwater harvesting systems can be developed to store water during periods of increased WD intensity and redistribute it when needed.

Received 23 July, 2024; Accepted 30 September, 2024

REFERENCES

Agarwal S, Suchithra AS and Singh SP 2021. Analysis and interpretation of rainfall trend using Mann-Kendall's and Sen's Slope method. *Indian Journal of Ecology* **48**: 453-457.

Bharath AL and Venkatesh B 2022. Precipitation Concentration Index and Rainfall Trend Analysis for South Western Districts of Karnataka India. *Indian Journal of Ecology* **49**(2): 462-469.

Dadial P, Singh M and Mehta P 2024. Trend and frequency distribution of western disturbances and its impact on major crops of Solan district of Himachal Pradesh. *Journal Of Agrometeorology* **26**(2): 190-195.

Dimri A P, Yasunari T, Kotlia BS, Mohanty UC and Sikka DR 2016. Indian winter monsoon: Present and past. *Earth-Science Reviews* **163**: 297-322.

Gill KK, Kaur S, Sandhu SS and Bhatt K 2021. Frequency of occurrence and duration of western disturbances in Punjab. *V-AGMET conference paper.*

Harshavardhan PL, Nayak PC and Kumar S 2020. Spatio-temporal rainfall variability and trend analysis for Krishna River Basin in India. *Indian Journal of Ecology* **47**: 54-59.

Hunt KMR, Baudouin JP, Turner AG, Dimri AP, Jeelani G, Pooja, Chattopadhyay R, Cannon F, Arulalan T, Shekhar MS, Sabin TP and Palazzi E 2024. Western disturbances and climate variability: A review of recent developments. *EGUsphere*: 1-106.

Jaswal AK, Bhan SC, Karandikar AS and Gujar MK 2015. Seasonal and annual rainfall trends in Himachal Pradesh during 1951-2005. *Mausam* **66**: 247-264.

Kumar M 2019. Effect of Climate Change on Indian Economy and Agriculture. International *Journal of Scientific Research and Review* **07**(01): 2279-543.

Mehta P, Jangra MS, Bhardwaj SK and Paul S 2022. Variability and time series trend analysis of rainfall in the mid-hill sub humid zone: a case study of Nauni. *Environment Science and Pollution Res*earch **29**: 66-76.