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Study on Long Term Trend Analysis on Occurrence of Dew at Raipur

J. L. Chaudhary [a*], Mridu Megha Dalai [a], Gunja Thakur [b], Krishna Murari [a] and Deepika Unjan [a]

[a] Department of Agrometeorology, College of Agriculture, Indira Gandhi Krishi Vishwvidyalaya, Raipur, C.G. 492012, India.
[b] Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G. 492012, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study on long term trend analysis on occurrence of dew was conducted during the 2022 year for long term data analysis of dew for the period 1991-2020 recorded at the Agro-meteorological Observatory, Research Area of Department of Agricultural Meteorology, Indira Gandhi krishi Vishwavidyalaya, Raipur, India. Based on study, daily dew observations were taken and converted into monthly and yearly dew observations. From the study, it was observed that there was significant decrease in dew amounts during the month of October, November and December. In addition to it, dew days of December month were found to be significantly decreasing. In yearly observation dew days found non-significant change and dew amount was found to be significantly decreasing. Correlation between dew amount and dew days has been tried and it was found that there exists the relationship between dew days and dew amount. In January, February, March, April, September and December months, there was positive correlation between dew days and dew amount. This indicates that if number of dew days increase, dew amount also increases. October

**Corresponding author: E-mail: jlcagromet@gmail.com;*

and November months are having non-significant values. In November month, there is negative correlation coefficient because of the fact that in this month on increase of dew days, there is visual observation of dew amount decrease, though it is non-significant.

Keywords: Dew; Agro-meteorology; dew point temperature; relative humidity; climate.

1. INTRODUCTION

Dew is a condensation in to liquid droplets of water vapour on substrate. The presence of a substrate is the origin of the peculiarities and richness of the phenomenon. When the moisture is deposited in the form of water droplets on cooler surfaces of solid objects (rather than nuclei in air above the surface) such as stones, grass blades and plant leaves, it is known as dew. The ideal conditions for its formation are clear sky, calm air, high relative humidity and cold and long nights. For the formation of dew, it is necessary that the dew point is above the freezing point. Most objects, including grass blades, leaves and petals, are much better radiators than air. As a result, they are usually colder at night than is the air. The cold surface cools the air in its vicinity and, if the air contains sufficient atmospheric humidity, it may cool below its dew point. When this happens, water vapour will condense out of the air onto the surface. The formation of dew is a common and natural process in which water vapour in the air condenses on a cooler substrate and transforms into liquid water. Dew is an important source of water that may significantly influence the physiological status of vegetation and the microclimate environment.

Meteorological factors which affect dew formations are relative humidity, wind speed and temperature. “Dew formation is favored by (i) a relative humidity at sunset of at least 75 percent (ii) wind speed less than 3 m/s and (iii) clear skies. Similarly, fog is nothing but cloud at ground level condensation of invisible water vapor in air into visible droplets of water and is provoked by the weather conditions (i) substantial heating during day time (ii) clear skies or very light, high clouds at night (iii) no or very light wind (iv) a thermal inversion at moderate height and (v) a sufficiently high atmospheric humidity” [1]. Relative Humidity (RH) is the amount of moisture in the air as a percentage of the maximum amount of moisture that the air could hold at the same temperature also known as the saturation point. Due to its direct relationship to fluctuating temperature, RH alone doesn’t provide enough information on how much moisture is in the air. As air gets warmer, it can hold more moisture. As a result if air temperature increases and the amount of moisture in the air stays the same, the RH will fall. The opposite is also true – if temperature falls and the amount of moisture in the air stays the same, the RH will rise. In both of these examples of changing RH there would be no change in the Dew Point, because the quantity of moisture in the air remains the same. An increase or decrease in Dew Point temperature happens when the actual quantity of moisture in the air changes. As a result, compared to the RH, the Dew Point temperature is relatively constant and changes in dew Point temperature are caused by weather systems. “The dew formation rate depends on the amount of water vapor in the air; this amount is related to the absolute humidity (i.e., the amount of gaseous molecules in the air) and the difference between the dew point and ambient temperature. This notion is expressed by the relative humidity (RH), which is defined as the amount of water vapor in the air at a given temperature with respect to the maximum amount of water vapor that the air can hold at that same temperature. It can also be defined as the contribution made by water vapour to the total atmospheric pressure over the maximum pressure that the water vapour can exert at the current temperature” [2]. “The wind speed is a key factor for dew formation. However, the function of wind for dew deposit is complicated. Although the strong wind enhances the heat exchange, this situation may homogenize the temperature quickly and decrease the temperature down below the dew point temperature. Recent findings on dew deposition on plant water relations and diurnal variations of photosynthesis in plants found that the leaves were able to absorb dew and thus restore plants water status” [3]. Therefore, keeping in view the significance of these weather parameters, an attempt has been made here to study the dew parameter for sustainable agricultural development.

2. STUDY AND METHODOLOGY

The dew data were taken from the Indian Meteorological Department recorded at the Agro

meteorological Observatory Research Area of Department of Agricultural Meteorology, Indira Gandhi krishi Vishwavidyalaya, Raipur, India. The dew observations were taken at height of 5cm, 25 cm, 50 cm and 100cm from ground level respectively. Systematic weather record of dew measurement was taken during the months (September to April) for the period 1991 to 2020 of Raipur and data have been considered for this study. In this study, data were subjected to correlation tests. The data series was so chosen because the rise in global temperature and climatic variability during these years was faster than in any other period [4] and maximum climatic variation had been reported during the recent decade.

3. RESULTS AND DISCUSSIONS

3.1 Monthly Dew Data Analysis

The observations on dew recorded at the Agro meteorological Observatory during the months have been mentioned in Table 1 during the period of 1991-2020. It was analyzed that there was significant decrease in dew amount during the month of October and November at the rate of 0.093 mm and 0.132 mm per year, respectively. The total average dew days of October month was found to be decreasing while for November month, average dew days were found to be increasing, whereas both dew average day and dew amount was found to be significantly decreasing at the rate of 0.158 mm in December month. The trend analysis of total average dew days and total average dew amount of October, November and December month was found to be significant. Therefore, the monthly data of these months are graphically depicted in Fig. 1, Fig. 2 and Fig. 3 respectively.

In many parts of the world, dew formation on plants is a common occurrence [5]. During monthly dew analysis for other months, it was observed that there was no significant increase or decrease was recorded. It was seen that for January month there is decrease in total average dew days and total average dew amount at the rate of 0.023 mm. For February month total average dew days were found to be decreasing whereas total average dew amount was seen increasing by 0.005 mm per year, but result observed for both were not significant. It was noted that for March month there is increase in total average dew days and total average dew amount by 0.011 mm but it was also not significant. From the below Table 1, it can be declared that the total dew average day and total average dew amount of April month was found to be increasing and decreasing, respectively but found to be non-significant. On the contrary, it was noticed that for September month, both total average dew days and total average dew amount decreased by 0.017 mm per year at non-significant pattern.

During total monthly analysis of total average dew days and total average dew amount it has been observed that dew amount and number of dew days started increasing from month of September to December and then decreased from Janurary to April. Dew amount may be decreased due to the absolute humidity of the atmosphere which affects the emissivity of the sky, with radiation being reduced when absolute humidity is high. For example, the high absolute humidity in environments such as wetland ecosystems or tropical climates hinders dew formation [6] (Xu *et al.* 2013). The wind speed is another key factor for vapour condensation. Strong wind can enhance heat exchange and homogenize the temperature quickly, which lowers the temperature to below the dew point temperature. Meanwhile, it makes the vapour diffuse rapidly. Breezes enhance the transition of water vapour and heat loss in the horizontal and vertical direction. The RH values in July and August were significantly higher than in other months ($P < 0.05$), resulting in increased vapor condensation at night during the rainy season [7]. An effort has been made to find out the correlation between dew amount versus dew days to find out whether there really exists the relationship between dew days and dew amount. In January, February, March, April, September and December, there is positive correlation between dew days and dew amount. This indicates that if number of dew days increase, dew amount also increases. October and November months are having non-significant values. In November month, there is negative correlation coefficient because of the fact that in this month on increase of dew days, there is visual observation of dew amount decrease, though it is non-significant (Table 2).

A plotting of dew days versus dew amount has been shown in Fig. 4. On average basis (of long term data base), increasing of dew days will indicate general increasing pattern of dew amount.

Table 1. Monthly dew data analysis (1991-2020)

Monthly data	Trend equation of total average dew day	R^2	Trend equation of total average dew amount	R^2
January	y = -0.101x + 27.96	0.055	y = -0.023x + 2.607	0.047
February	y = -0.109x + 19.01	0.018	y = 0.005x + 1.048	0.002
March	y = 0.112x + 3.655	0.024	y = 0.011x + 0.151	0.058
April	y = 0.012x + 0.173	0.011	y = -0.000x + 0.013	0.002
September	y = -0.087x + 15.07	0.019	y = -0.017x + 1.242	0.115
October	y = -0.015x + 25.02	0.00	y = -0.093x + 4.655	**0.389***
November	y = 0.166x + 23.57	0.108	y = -0.132x + 5.769	**0.407***
December	y = -0.167x + 31.07	**0.219***	y = -0.158x + 6.412	**0.460***

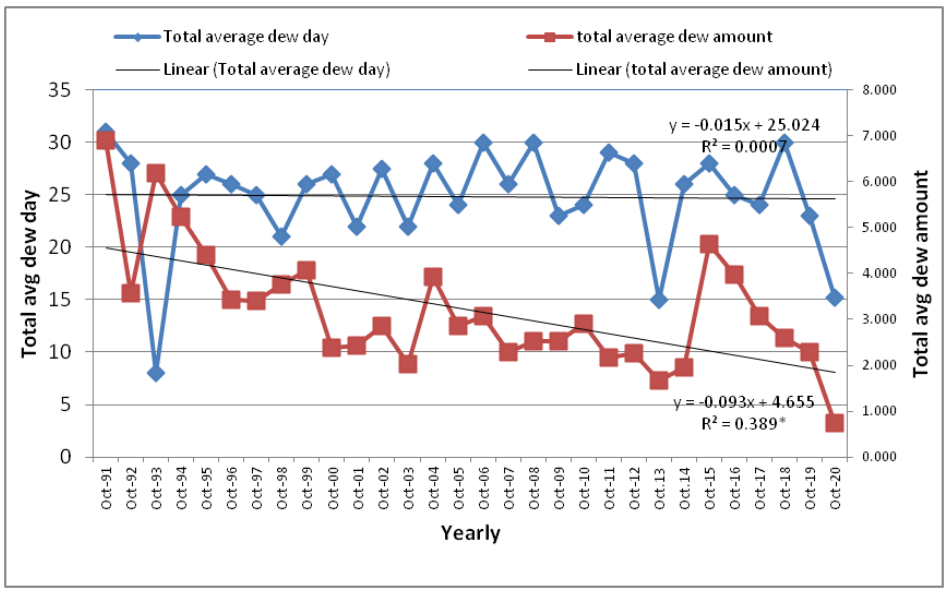

Fig. 1. Trend analysis of total average dew days and total average dew amount of October month

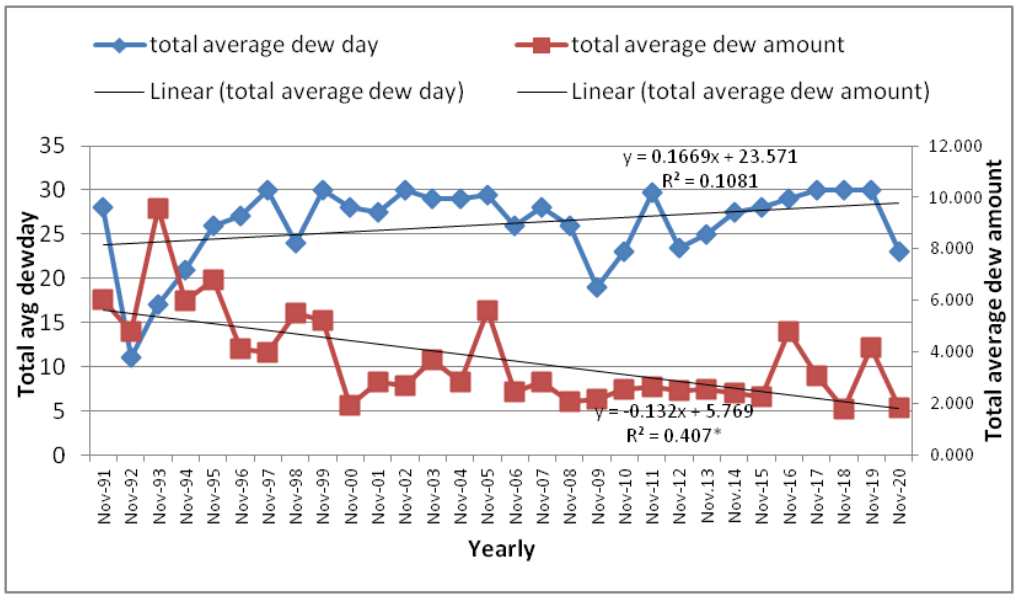

Fig. 2. Trend analysis of total average dew day and total average dew amount of November month

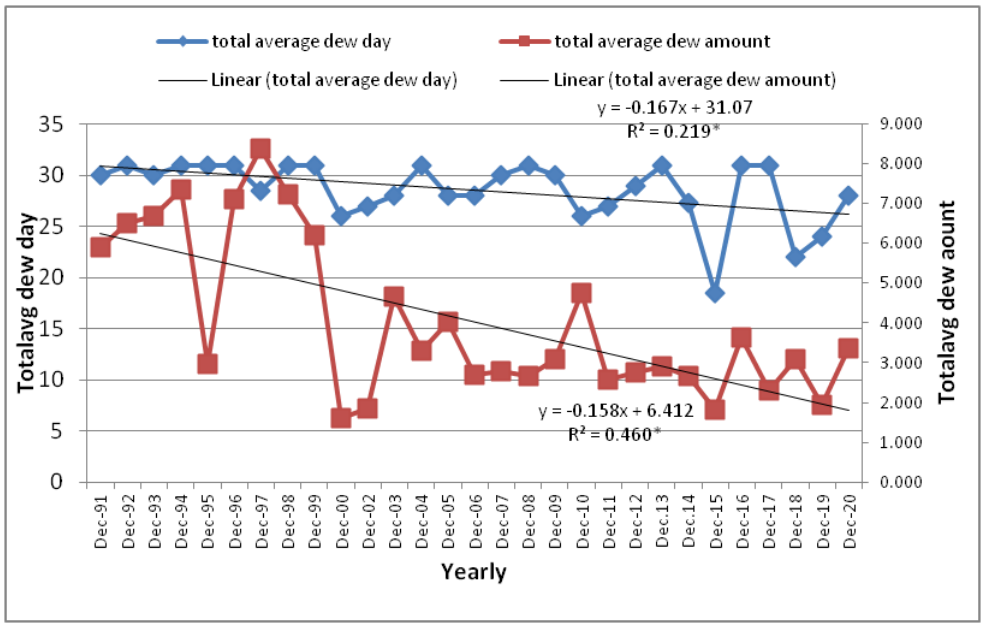

Fig. 3. Trend analysis of total average dew day and total average dew amount of December month

Table 2. Correlation coefficient values between dew days and dew amount

Months	Total average dew days	Total average dew amount (cm)	Correlation
Jan	27	3.0	0.352*
Feb	17	1.1	0.596**
March	5	0.3	0.777**
April	0.3	0.011	0.806**
Sept	14	1.0	0.754**
Oct	25	3.2	0.1
Nov	26	3.7	-0.287
Dec	29	4.0	0.42*

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

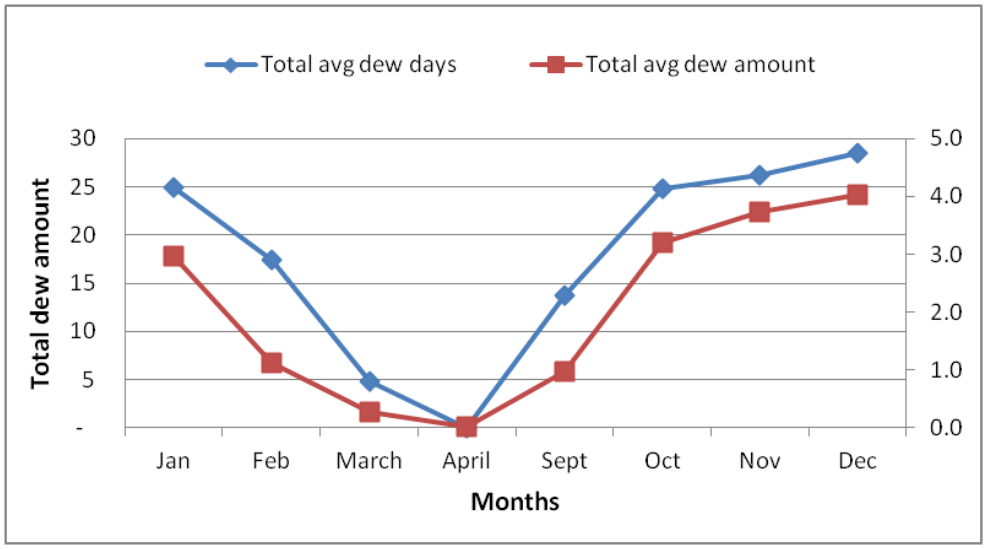

Fig. 4. Plot of total average dew days and total average dew amount in Dew months

Table 3. Yearly dew data analysis (1991-2020)

Yearly data	Trend equation of total average dew day	R^2	Trend equation total average dew amount	R^2
1991-2020	y = -0.003x + 140.5	0.00	y = -0.362x + 20.51	**0.404***

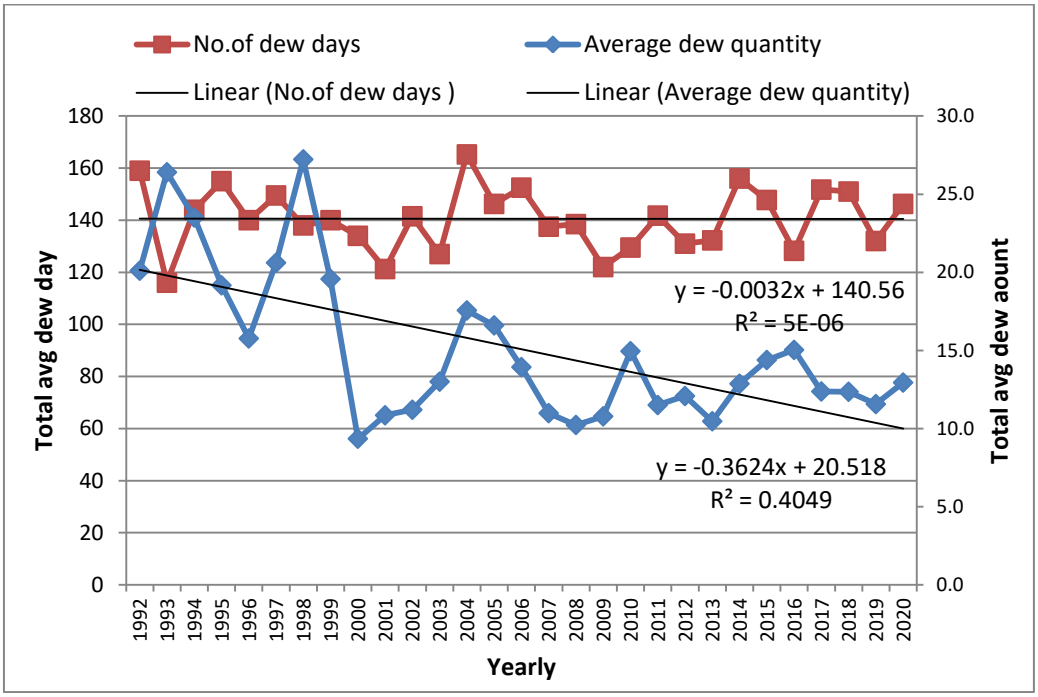

Fig. 5. Yearly Trend analysis of total average dew day and total average dew amount

3.2 Yearly Dew Data Analysis

The observations on dew recorded at the Agro meteorological Observatory during the period of 1991-2020 have been tabulated in Table 3 and graphically represented in Fig. 5. According to the data it was analysed that yearly total average dew days found non-significant change and total average dew amount was found to be decreasing significantly at the rate of 0.362 mm per year.

4. CONCLUSION

Under specific environmental conditions dew can be captured and may yield substantial amounts of water which can be used for domestic purposes, livestock and establishment of trees or for the growth of crops to achieve the objective of alternate source of water. From the study, it can be concluded that long term analysis of monthly dew data (1991-2020) was observed constantly decreasing as we observed for October, November and December month. In these months both total average dew days and total average dew amount was found to significantly decreasing. Therefore, yearly dew data was found to be decreasing over the years. The result obtained may be due to high climatic fluctuations in weather parameters like increase in global warming, green house effect which caused increase in temperature which affect other parameters like rainfall, relative humidity, dew and many other. The impact of dew on agricultural crops for growth and development, inputs from various specialized disciplines and allied sciences engaged in meteorological applications along with forecasting skills from non scientific quarters are needed to predict the weather parameter accurately [8], thus the active cooperation between meteorological/remote sensing agencies, agricultural organizations and farming community is needed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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