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Short Communication

Dew trend analysis and its potential implications in rainfed agriculture

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The current scenario of climate change has increased the frequency and magnitude of atmospheric stress related extremes like heat wave and dry-spells (Bal and Minhas, 2017). The result is an increase in the demand and competition for freshwater among agriculture and non-agricultural sectors. This has drawn our attention towards dew as an additional or supplementary source of water. Dew can be a significant substitute to overcome the problem of water scarcity up to some extent, especially under rainfed agro-ecosystems. Hence, an effort was made to assess the extent of dew accumulation and it's trend that could mitigate water deficiency and augment soil moisture regime for possible agronomic exploitation in the future in water scanty regions. It is a well known fact that the formation of dew largely depends on the dew point temperature. The estimated diurnal variation of dew point by and large, follows a set pattern depending upon the morning dew point temperature (Srivastava *et al.,* 2011). Therefore, the scientific analysis of dew deposition will provide a general idea about the amount and trend of dewfall in the region.

Daily dew accumulation data of 27 years (1993-94:2019-20) from October to February were collected from the meteorological observatory of ICAR-Indian Institute of Soil and Water Conservation (IISWC), Research Centre, Kota, Rajasthan (25º 11' N latitude and 75 º 51' E longitudes with 256.9 m above mean sea level) at four height levels viz. 5, 25, 50 and 100 cm above the ground surface using Duvdevani dew gauge (Duvdevani, 1947). The dew deposited on wooden planks at four different heights was compared with photographs of dew album and recorded the amount of dew deposition. The descriptive statistical analysis was used to determine the minimum, maximum, mean, standard deviation (SD), and coefficient of variation (CV) of dew deposition. Linear regression model was used to identify the dew deposition trend over the years (Gomez and Gomez, 1984). The equation of the linear regression is expressed as follows:

$$Y=a+bx$$

The least-square method was used to calculate the coefficients a and b. The probability value (P value) is used for significance ($\propto = 0.05$) of the slope line.

Role of dew in crop production

Dew water offers a potential renewable and complementary source of water for rainfed, arid and semi-arid climate (Sharan *et al.,* 2016). The water balance of plants can be altered by interference of dew droplets with the leaf energy balance, which leads to reduced leaf temperature and suppression of transpiration through evaporative cooling and increased leaf albedo and emissivity (Lakatos *et al.,* 2012; Gerlein-Safdi *et al.,* 2018). Dew can also compensate the additional demand of water in the regions with higher evapotranspiration than precipitation (Glenn *et al.,* 1996; Gabin, 2015). Plants can also restore water status through dew absorption by leaves (Munne-Bosch and Alegre, 1999). However, the changing climatic conditions with induced plant water stress, carbon cycle, and water and energy fluxes are expected to influence the frequency and amount of dew depositions in varied agro-ecologies. Further, dew is relatively neglected subject in both rainfed and semi-arid agro-ecosystems. Hence, the analysis dew deposition amount and pattern has been carried out to assess the potential of dew to offset the part of water demand for use in crop production in the future.

Characteristics of seasonal dew deposition

The seasonal (October to February) dew deposition of the region ranged from 14.8 to 54.8 mm. This variation in dew deposition amount indicates that the seasonal dew deposition pattern is highly erratic with time (Table 1). The highest (54.8 mm) total seasonal dew deposition was recorded in the year 1994-95 with the corresponding highest mean monthly value of 11.0 mm. The data indicated that standard deviation of the highest total seasonal dew deposition year (1994-95) was 5.1 mm. Besides, the lowest annual dew deposition (14.8 mm) occurred in 2017-18 and a corresponding seasonal mean value was 3.0 mm. The CV

Table 1: Statistical summary of seasonal dew deposition (Oct. to Feb.) from 1993-94

Year	Seasonal(mm)	Min (mm)	Max (mm)	Mean (mm)	SD (mm)	CV (%)
1993-94	49.2	5.4	14.8	9.9	3.6	36.7
1994-95	54.8	6.5	19.4	11.0	4.9	45.0
1995-96	50.4	5.8	18.7	10.1	5.1	50.8
1996-97	32.8	3.7	9.2	6.6	2.2	34.0
1997-98	44.4	5.9	16.6	8.9	4.4	49.6
1998-99	37.7	5.2	11.2	7.6	2.5	32.6
1999-20	39.4	3.0	15.9	7.9	4.8	61.1
2000-01	28.3	2.4	11.1	5.7	3.7	65.5
2001-02	39.7	3.5	11.4	7.9	3.5	43.5
2002-03	19.7	0.2	7.2	3.9	3.2	80.5
2003-04	40.0	3.2	14.9	8.0	5.1	63.7
2004-05	23.9	2.1	9.1	4.8	3.0	62.8
2005-06	29.3	1.8	10.1	5.9	3.0	51.4
2006-07	34.4	2.2	13.5	6.9	4.3	62.0
2007-08	28.6	2.5	10.7	5.7	3.2	55.5
2008-09	27.8	1.9	9.1	5.6	3.4	61.2
2009-10	30.6	2.0	9.5	6.1	3.7	61.1
2010-11	20.2	0.5	9.1	4.1	3.2	79.6
2011-12	32.6	4.2	9.3	6.5	2.5	38.1
2012-13	34.9	3.6	12.7	7.0	3.7	52.9
2013-14	33.1	3.2	10.0	6.6	2.9	43.7
2014-15	35.4	3.8	9.2	7.1	2.0	28.8
2015-16	29.2	2.3	9.0	5.8	2.8	47.5
2016-17	20.0	2.3	6.5	4.0	2.1	52.5
2017-18	14.8	0.6	7.0	3.0	2.6	89.1
2018-19	34.8	3.1	8.7	7.0	2.3	32.5
2019-20	24.1	4.3	5.8	4.8	0.6	12.5

of average seasonal dew was ranging from 12.51 to 89.12%. CV indicates degree of variability such as low (CV < 20%), moderate (20 < CV < 30%), high (CV > 30%), very high (CV > 40%) and extremely high (CV > 70%) (Panda and Sahu, 2019). Based on this, from the observed data considered that all the years had above 30% of CV, except 2019-20 (12.5%) and 2014-15 (28.8%) highlighting the moderate variability of dew deposition over the area. The year 2017-18, 2002-03 and 2010-11 recorded the highest CV of 89.1, 80.5 and 79.6% respectively, which indicates that the amount of dew deposition was extremely variable during these years. According to Dewar and Wallis (1999), the variation of CV values indicates the existence of strong variability in the dew deposition pattern over the study area.

Characteristics of monthly dew deposition

The mean seasonal (October to February) dew deposition during 27 years of study period (1993-94 to 2019-20) was 33.1 mm with 9.9 mm SD and 29.9% CV (Table 2). The highest mean dew deposition was observed in January (9.2 mm) and December (8.8 mm) with 4.2 mm and 2.8 mm SD and 45.4% and 32% CV, respectively. However, the lowest amount of dew deposition (4.3 mm) was recorded in the month of February with 2.0 mm SD and 46.1% CV. The

Table 2: Statistical summary of monthly dew deposition from 1993-94 to 2019-20

Month	Min (mm)	Max (mm)	Mean (mm)	SD (mm)	CV (%)
October	0.2	11.4	4.9	3.1	63.1
November	1.1	10.1	5.8	2.8	48.0
December	3.2	15.9	8.8	2.8	32.0
January	4.3	19.4	9.2	4.2	45.4
February	0.6	7.8	4.3	2.0	46.1
Total dew deposition	14.8	54.8	33.1	9.9	29.9

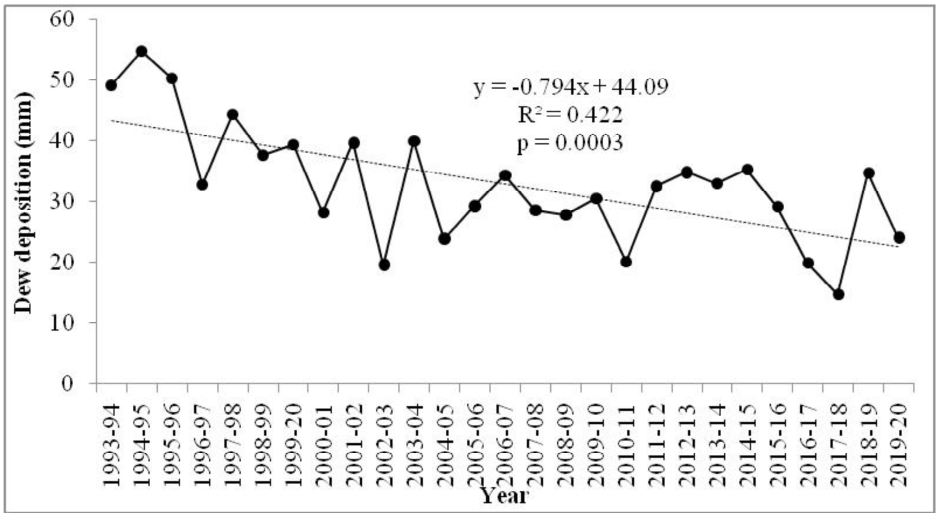

Fig. 1: Trend of total seasonal dew deposition from 1993-94 to 2019-20

higher relative humidity, mild wind, and low-temperature conditions may be facilitated the higher dew deposition in the month of January and December (Ye *et al.*, 2007; Zhang *et al.*, 2015).

Trend of seasonal dew deposition

The trends of different time series viz. seasonal dew deposition for 27 years from October to February were analyzed using linear regression model and are presented in Fig. 1. The seasonal dew deposition showed a declining trend from 1993-94 to 2019-20 (Fig. 1). Since the probability value (p value) from the regression analysis was lower than the significant level ∝ = 0.05, indicating that there was a statistically significant ($p < 0.001$) trend of the seasonal dew deposition for Kota region of South-eastern Rajasthan. Additionally, the R-square statistic ($R^2 = 0.42$) also indicated a strong relationship between the dew deposition and year.

Trends of monthly dew deposition

A declining trend of dew deposition was also observed for all the dew occurring months i.e. October, November, December, January, and February (Fig. 2). The trend was statistically significant for the months of December (p d” 0.05) and January (p d” 0.001). However, the trend was statistically non-significant for October, November, and February. This fact is clarified by the P values of greater than ∝ = 0.05. The study revealed that monthly dew deposition showing decreasing trends over the years.

The dewfall characteristics especially amount of dewfall, variability and trend are necessary for the proper planning of crop management such as the selection of crops and varieties, sowing time, irrigation management, etc. The results indicate significance of dew deposition for the planning of crop cultivation in the present era of climate change, especially under rainfed conditions. Hence, farmers need to make some changes in their cropping pattern to cope with changing dew deposition patterns like switching over to less water demanding crops, such as pulse, millets, etc.

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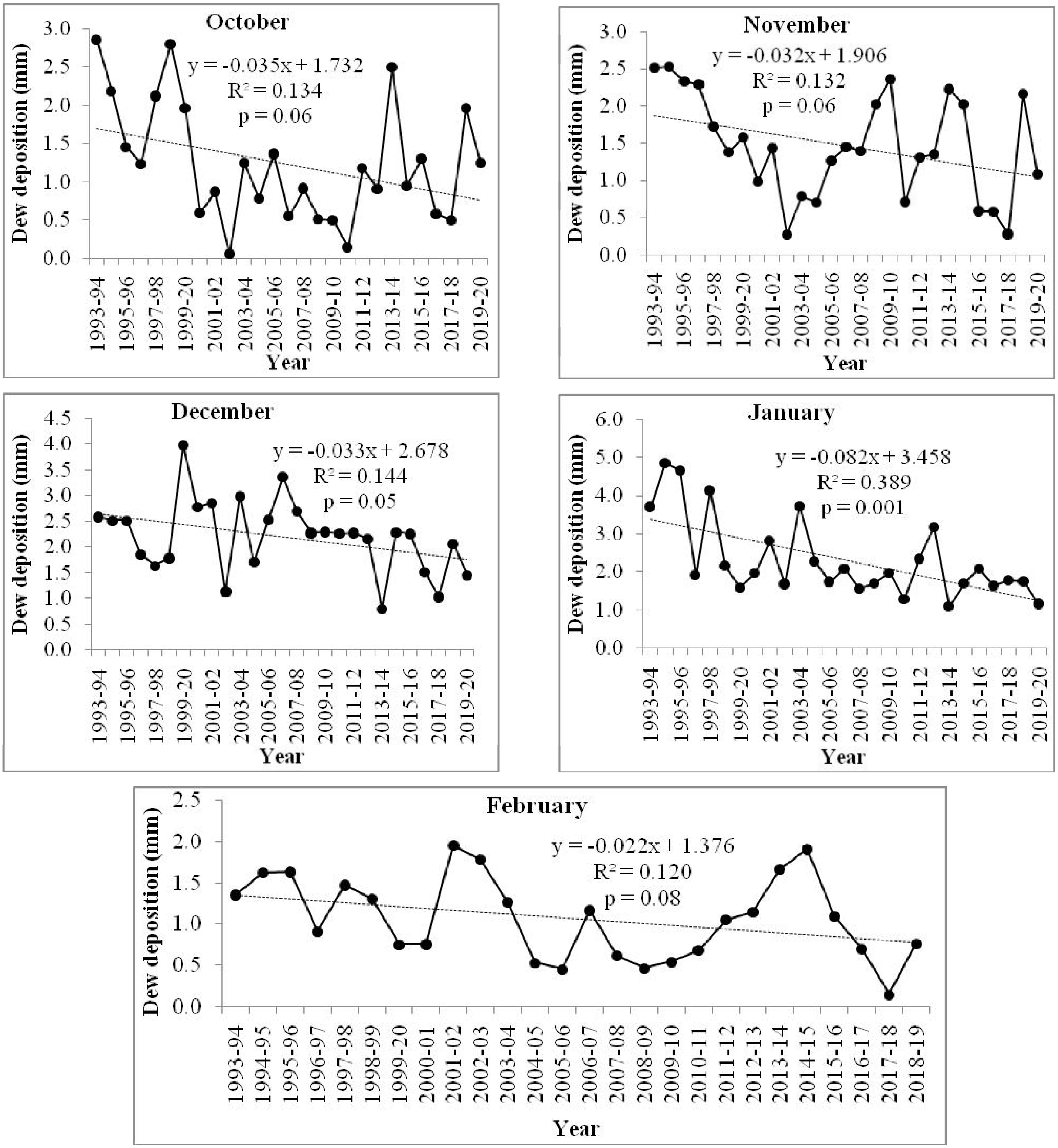

Fig. 2: Trend of monthly (October to February) dew deposition from 1993-94 to 2019-20

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