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FOG AND DEW CLIMATOLOGY OVER HISAR, INDIA

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Abstract

In many arid and semi-arid areas, pumped ground water and the water from streams, rivers and reservoirs is no longer sufficient to cover the ever increasing water demand. Therefore new interest in 'marginal' water resources like fog & dew harvesting are to be developed after studying climatology of these parameters in a region. The observations on dew and fog events recorded at Hisar, representing semi-arid region of India during winter season (October to March) for the period 1980 to 2005 have been analyzed. The total annual dew amount in winter season ranged between 33 mm (1987-88) and 79 mm (1981-82) during the period under study. The seasonal dewfall showed a decreasing trend of 1.4 mm during the period under investigation. Average maximum dew events (26.1) were recorded during November and average minimum dew events were recorded in February. In a particular season, the highest dew events (168) were observed during the winter seasons of 1982-83 and 1983-84, whereas, the minimum number of dew events (97) was reported during 1998-99. Interestingly, an increasing trend (1.3 day/season) in occurrence of fog events was seen. Average maximum foggy events (8.7) recorded in a month were observed in January. In a particular season, the maximum foggy events (41) were recorded during 2002-03 and the minimum (2) during 1983-84. To achieve the objective of alternate source of water and to assess the impact of dew and fog on agricultural crops for their 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, thus the active cooperation between meteorological/remote sensing agencies, agricultural organizations and farming community is needed for sustainable agricultural development in scarce/limited water availability regions.

1. INTRODUCTION

Water scarcity will be one of the major threats to humankind during the current century. As the available water resources taken from streams, rivers and ground water will not be sufficient in most dry areas of the world to cover the needs of agriculture and urban areas, we have to reassess the value of certain methods of water harvesting from fog and dew, to find out their value to ease future water scarcity (Prinz and Singh 2000)**.** Dew and fog are very simple phenomena in nature but they prove to be very difficult to understand. The dew drops are tiny drops of moisture when air, coming in contact with a cool surface is condensed and the moisture present, is deposited on the surface. 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. Under specific environmental conditions fog and dew can be captured and may yield substantial amounts of water which can be used for domestic purposes, livestock, establishment of trees, or for the growth of crops. In order to supplement the moisture collected by plants themselves artificial surfaces can be exposed, such as, netting-surfaced traps, or polyethylene sheets. Small and simple installations for the condensation of fog or dew can yield several litres of water per day (Acosta Baladon, 1995). Dew formation and evaporation has been a relatively neglected topic in both desert meteorology and in arid ecosystem research (Berkowicz *et al.,* 2001). 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 (Munne-Bosch and Alegre, 1999). Therefore, keeping in view the significance of these weather parameters, an attempt has been made here to study the dew and fog climatology in semi-arid regions of India so that alternate methods of water harvesting may be explored in the region for sustainable agricultural development.

2. STUDY AREA AND METHODOLGY

The Hisar, representing the western agroclimatic zone of Haryana, India (Fig.1) is situated in sub-tropics (Latitude $29^0$10' N, Longitude $75^0$46'E, Altitude 215.2 m amsl). The zone is land locked from all sides. The zone has semi-arid climate and is generally very hot in summers and remarkably cold in winters. High temperatures of 45°C magnitude are recorded during the month of May in most parts of the region, whereas, in winters the temperature goes down to –2 to –3°C for a few days. Most of the rainfall (75 to 80 %) is received in the SW monsoon season from June to September. Rainfall ranges from ~ 300 to 500 mm and the zone can be classified as moisture deficit. Systematic weather records during the winter seasons (October to March) for the period 1980 to 2005 for Hisar have been considered for this study. 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 (Anonymous, 2000) and maximum climatic variation had been reported during the recent decade. The dew and fog data were taken from CWS 27 (b) format of the India Meteorological Department recorded at the Agrometeorological Observatory at the Research Area of Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar, India. The dew observations at 50 cm height were considered for study as more dew events were recorded at this height.

2.1. General climatology of the region

The South-West monsoon brings rain from June to September contributing to about 75 to 80 percent of the total annual rainfall. From October to mid April, the weather remains almost dry except for a few light showers due to western disturbances during these months. Later on the weather remains quite dry till mid June with high temperatures. A major part of South-West Haryana is arid/semi-arid receiving 300-500 mm rainfall per annum. Not only the quantum of rainfall low in this region but its variability is also very high.

An average minimum temperature of 5-6^0C is recorded in the months of December and January. The high temperature (35^0C) in the months of mid-September to mid-October are responsible for delayed sowing of winter crops after the monsoon withdrawal in early September. Total yearly US open pan evaporation average is 2592 mm with a maximum rate of 14 mm/day in the month of June. An average potential

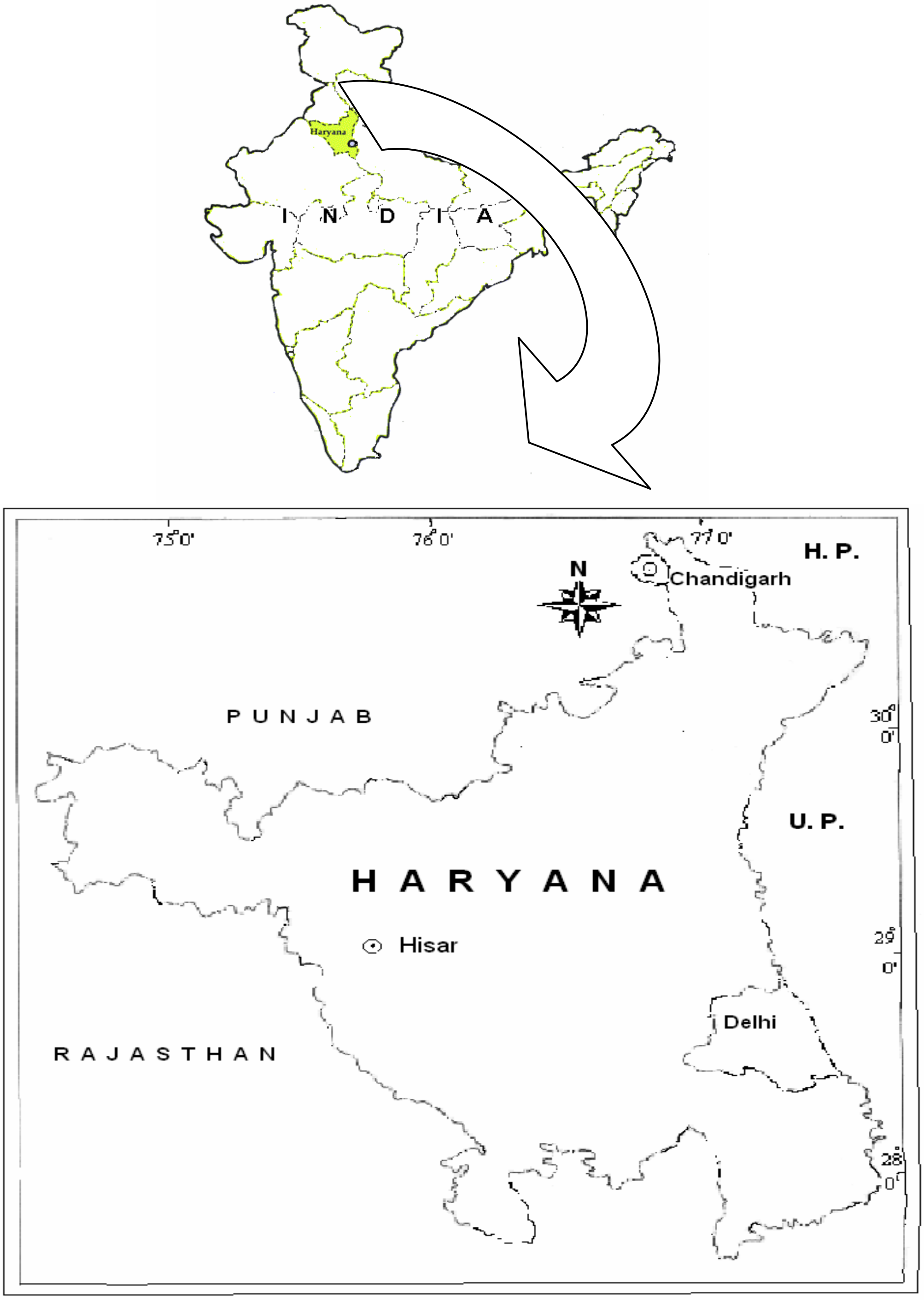

Fig 1. Map depicting study area

evapotranspiration of 5.3 mm/day is observed during July - October and 2.7 mm/day during November - February.

2.2. Cropping pattern in the region

The south-west Haryana grows important dryland crops of bajra, jowar (fodder) and guar during *Kharif* (rainy season) and chickpea, mustard and barley during *rabi* (winter season). Inter and mixed cropping of guar, moong, cowpea, mothbean, til, bajra and mixed cropping of mustard in chickpea are common. The cropping intensity in rainfed areas seldom exceeds 100 percent. In irrigated agriculture, wheat, barley and mustard occupy major areas. However, in some parts cotton and sugarcane are also cultivated under irrigated conditions.

3. RESULTS AND DISCUSSION

The observations on dew and fog occurrence recorded at the Agrometeorological Observatory during the winter seasons of the last 25 years (1980-2005) were analyzed. In a particular winter season, the highest foggy events (44) were recorded during 2002-03 and the minimum (2) during 1983-84 (Fig. 2). Interestingly, an increasing trend (1.3 day/season) in occurrence of fog events was seen. About 67 percent variation in fog events was explained over the time under investigation.

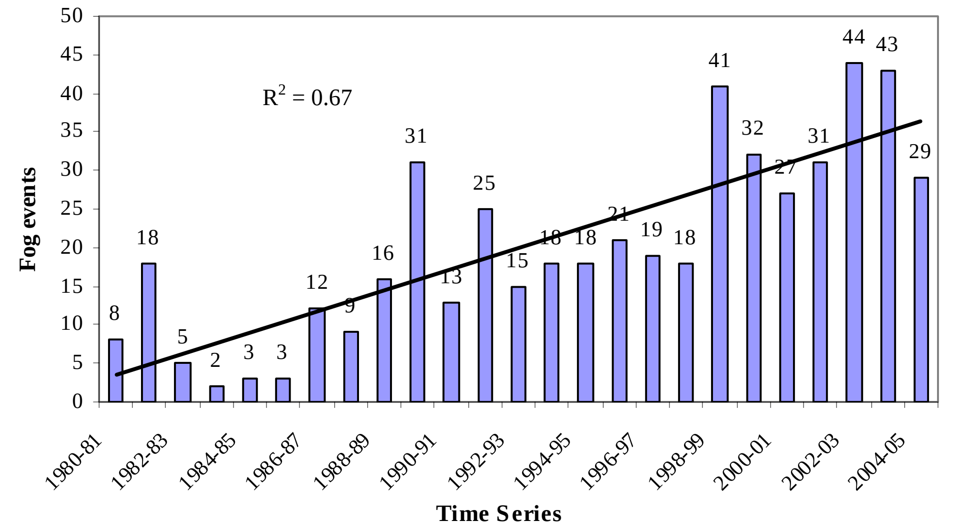

Fig 2: Number of fog events at Hisar, India (1980-2005)

In many parts of the world, dew formation on plants is a common occurrence (Garratt and Segal, 1988). Moreover, it is generally assumed that leaf surface wetness has the most direct influence on pathogen activity affecting plant growth and development (Jacobs *et al*., 1990). In a particular season, highest dew events (168) were observed during the winter seasons in 1982-83 and 1983-84. Whereas, the minimum number of dew events (97) were reported in 1998-99 (Fig. 3). The average dew events/season for study period was 130. A decreasing trend (2.2 day/season) in occurrence of dew events was noted during the period under report. Average maximum dew events (26.1) were observed during November and average minimum dew events were recorded in February.

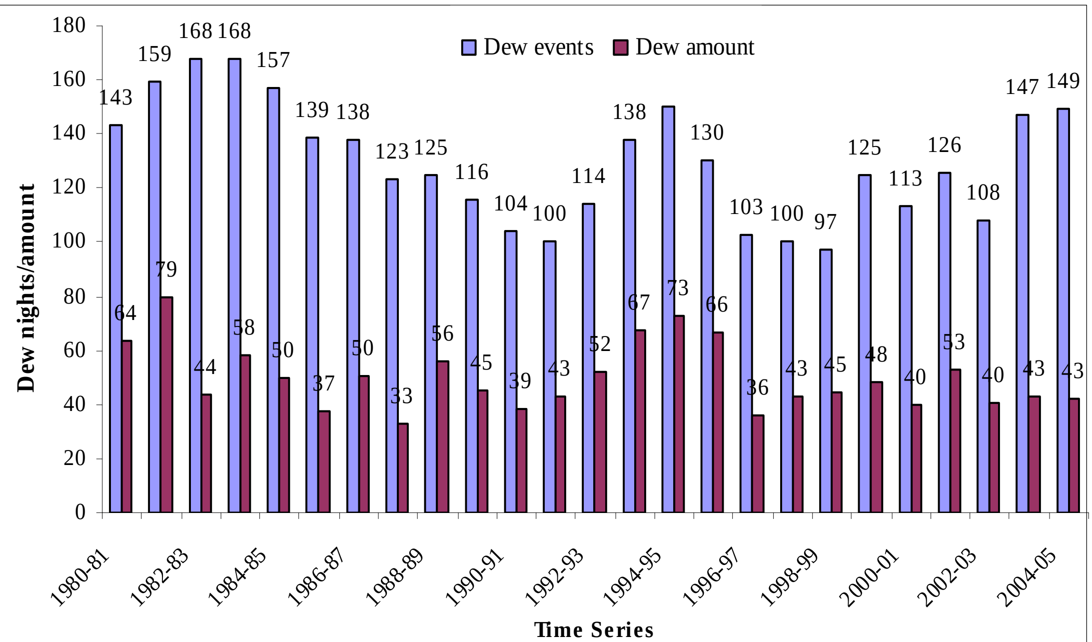

Fig 3. Dew nights and amount (mm) at Hisar, India (1980-2005)

November and January months recorded highest average dew (26.1) and fog (8.7) events, respectively (Fig. 4). The lowest monthly average dew (18) and fog (0.4) events were recorded during January and October, respectively. The dew and fog events showed a reciprocal trend during the winter season because of little difference in droplet size and therefore, an event has been converted into another form/event. Knowing the fog climatology of a region, the fog harvesting potential to provide freshwater for different purposes in arid and semi-arid regions can be explored through simple and low-cost fog collecting machines. The highest (79 mm) and lowest (33 mm) dewfall amount was received during the observation season in 1981-82 and 1987-88, respectively. Also, the dewfall exhibited a linear decreasing trend 1.4 mm/season during the period under investigation.

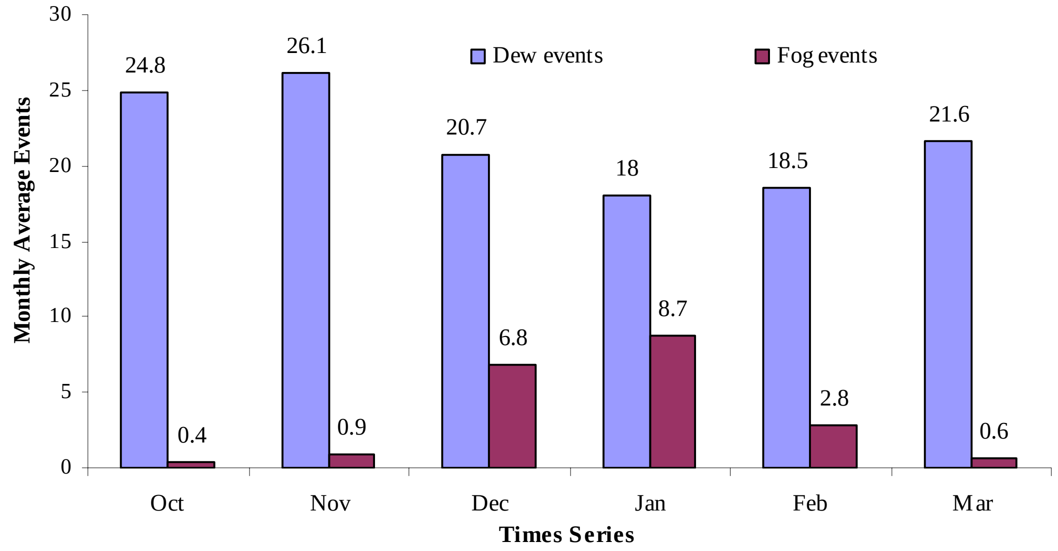

Fig 4. Monthly average dew and fog events at Hisar, India (1980-2005)

Fog which often occurs in the winter time during stable weather situations plays an important role in tropics affairs and air quality all over the world. Fog climatology based on satellite remote sensing using time series data is important because long term knowledge of regional changes in fog frequency and fog properties are of overall importance for GCM simulations dealing with global climate change (Singh *et al.*, 2001).

4. CONCLUSIONS

Under specific environmental conditions fog and dew can be captured and may yield substantial amounts of water which can be used for domestic purposes, livestock, establishment of trees, or for the growth of crops. In order to supplement the moisture collected by the plants themselves, artificial surfaces can be exposed such as netting-surfaced traps, or polyethylene sheets. Small and simple installations for the condensation of fog or dew can yield several litres of water per day. The feasibility of a fog water collection system depends on the availability of a site where relatively large amounts of water can be collected. To achieve the objective of alternate source of water and to assess 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 (Singh *et al.,* 2004), thus the active cooperation between meteorological/remote sensing agencies, agricultural organizations and farming community is needed to maintain sustainable agricultural development in scarce/limited water availability regions.

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