Dew as a Source of Plant Moisture

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RECORDS OF THE FREQUENCY of occurrence or of the total amounts of dew are scarce. This is surprising in view of the fact that dew has been used for water supply in certain Mediterranean countries for many centuries. The lack of records can undoubtedly be attributed to the difficulty of making quantitative measurements.

Dew is the moisture which condenses from the atmosphere on plants, soil, or other surfaces near the ground. Common experience tells us that dew forms primarily during the early morning hours when the temperature approaches its minimum diurnal value. It often forms in the early evening also, and in such cases probably continues to accumulate slowly throughout the night. However, the rate of formation must decrease owing to the fact that the layer of air closest to the ground becomes saturated. The vapor pressure gradient at the immediate surface of ground becomes nearly zero and probably stays near zero because of lack of mixing in the lowest layers.

Temperature in a standard instrument shelter may give little clue to the probability of dew formation at the ground surface. The temperature gradient increases so rapidly in the lowest few feet near the ground that temperature at grass level is considerably lower than at the height of the instrument shelter. Radiational cooling is, of course, the cause of the low temperatures at ground level. It follows that dew will be heaviest on surfaces which are the best radiators, that is, dark and opaque surfaces such as green grass. For the same reason, dew will be heaviest when the wind is light or absent because the lack of mixing allows the temperature inversion near the ground to be maintained and to intensify.

Only plants which are shallow rooted could make use of dew because the moisture penetrates only a thin layer of soil and evaporates quickly when the sun begins to warm the surface. Pineapple is an example of a plant whose trough-shaped leaves allow dew to run down to the plant base. This tends to concentrate the dew water near the roots, which, being shallow, can utilize the dew with some efficiency. Dr. Gordon Nightingale measured with a pipette appreciable amounts of dew water which collected at the axil of pineapple leaves (personal communication). I have frequently observed the ground at the base of the pineapple stem to be noticeably moist as a result of dew collected by the leaves. The shade cast on the plant base by the leaf mass enhances the probability of intake by roots inasmuch as the shade reduces the evaporation rate.

My own experience in the semiarid southwestern United States supports the view that dew is sufficiently frequent to constitute, in all probability, an important source of moisture for some plants. Measurements of the frequency of dew in Hawaii tend to confirm this conjecture. Because data on dew frequency are uncommon, the record of measurement made during 2 years in Honolulu is of some interest.

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The record was made in Kahala, a section of the city of Honolulu just east of Diamond Head, where the mean annual rainfall is approximately 20 inches. Every morning about 7 o'clock I walked across the lawn to read the rain gauge and at that time observed the relative amount of dew which collected on my shoes. The procedure has more an air of levity than of science but such a record is better than none. It was observed that this daily procedure provided enough experience to allow a consistent estimate of the relative amount of dew. The amount was recorded as one of four categories—none, light, moderate, or heavy. On days of rain, no record of dew was made because one could not tell whether the moisture was derived from dew or from precipitation.

Deducting from each month the number of days of rain or no record, the frequency of dew can be expressed as percentage of days. This represents, in other words, the percentage of possible days on which dew could occur in the absence of rain. The number of days, by months, is presented in Table 1. The annual march of dew occurrence is shown graphically in Figure 1.

TABLE 1

FREQUENCY OF OCCURRENCE OF DEW AT HONOLULU DURING THE PERIOD OF OCTOBER, 1947, TO JULY, 1949

MONTH	TOTAL DAYS ON WHICH DEW WAS OBSERVED	TOTAL DAYS OF NO RAIN	PERCENTAGE RAINLESS DAYS
January	23	35	66
February	27	45	60
March	16	45	35
April	12	42	29
May	19	52	37
June	12	45	27
July	2	15	13
August	13	52	25
September	15	53	28
October	25	48	52
November	27	43	64
December	7	23	30
Total	198	498	40

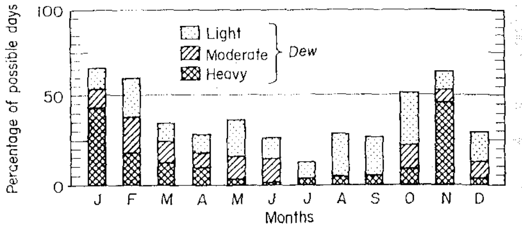

FIG. 1. Frequency of dew at Honolulu (as percentage of rainless days).

Despite the rough manner of collecting the data, the relatively smooth annual march lends credence to the record. The December percentage is low. This can probably be attributed to the fact that one of the two Decembers of record was relatively windy as indicated by a concurrent anemometer record. For July only one-half month of record is available.

Dew occurred on 198 days, which represented 40 per cent of the total rainless days. At the same place and in the same period, there were 217 days of some rain. Traces of rain were not counted as rain days. Of the 217 rain days, only 89 had amounts greater than 0.1 inch.

On many days of heavy dew, enough collected on the funnel of the rain gauge to drip into the collection tube where it could be measured as .01 inch. Assuming that the average amount of dew was .0075 inch in a day, which is indeed a guess but probably of the right magnitude, the dew contributed 0.8 inch per year. Let us compare this with the moisture contributed by light rains or showers. The total rain contribution of those days on which .01 to .09 inch of rain occurred was 2.6 inches per year. Of the total annual rainfall, the dew moisture would constitute about 4 per cent, while rain in the category .01–.09 inch in a day would constitute 13 per cent of the total.

The frequency of dew at Honolulu is greatest in winter and least in summer. Mixing ratio (grams of water vapor per gram of dry air) has a small annual variation with a maximum in late summer. The seasonal variation of temperature is also small. The mean temperature at Honolulu varies from about 71°F. in February to 78° in August (Palmer, 1950). The modest decrease of temperature during the winter months overcompensates for the winter minimum of moisture and enhances the possibility of reaching the dew point by radiational cooling at the ground surface. The annual march of dew frequency thus appears directly related to the annual march of minimum daily temperature.

The importance of dew lies not in the total quantity but in the frequency of occurrence. At the Kahala station there were nearly as many days of dew as days of rain. Because of the frequent showers in the trade-wind belt, the number of days of rain is unusually high relative to the annual rainfall.

Recent work has shown that radiational cooling of the ground surface causes moisture to condense within the pore spaces of the surface layer of soil. This moisture condenses out of the air which is in the soil pores. It has been demonstrated that this moisture is sufficient to affect soil moisture of road subgrades (Winterkorn, 1944), and it is possible that the same process also can provide water to plants.

Consider these facts in relation to the grasslands of the world. Grass or desert shrub characterizes a very large geographic area where the annual rainfall is roughly between 6 and 14 inches. Such areas are, by their meteorologic setting, characterized by a large number of days of no rainfall, and most of the annual rainfall occurs in relatively few days. It is reasonable to suppose, then, that in such an ecologic setting any factor which doubles the frequency of moisture availability, even though the moisture amounts be small, must materially affect the growing conditions of plants. It is suggested, therefore, that the occurrence of dew is a factor of some importance in sustaining the plant associations in grasslands and some xerophytic habitats.

REFERENCES

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