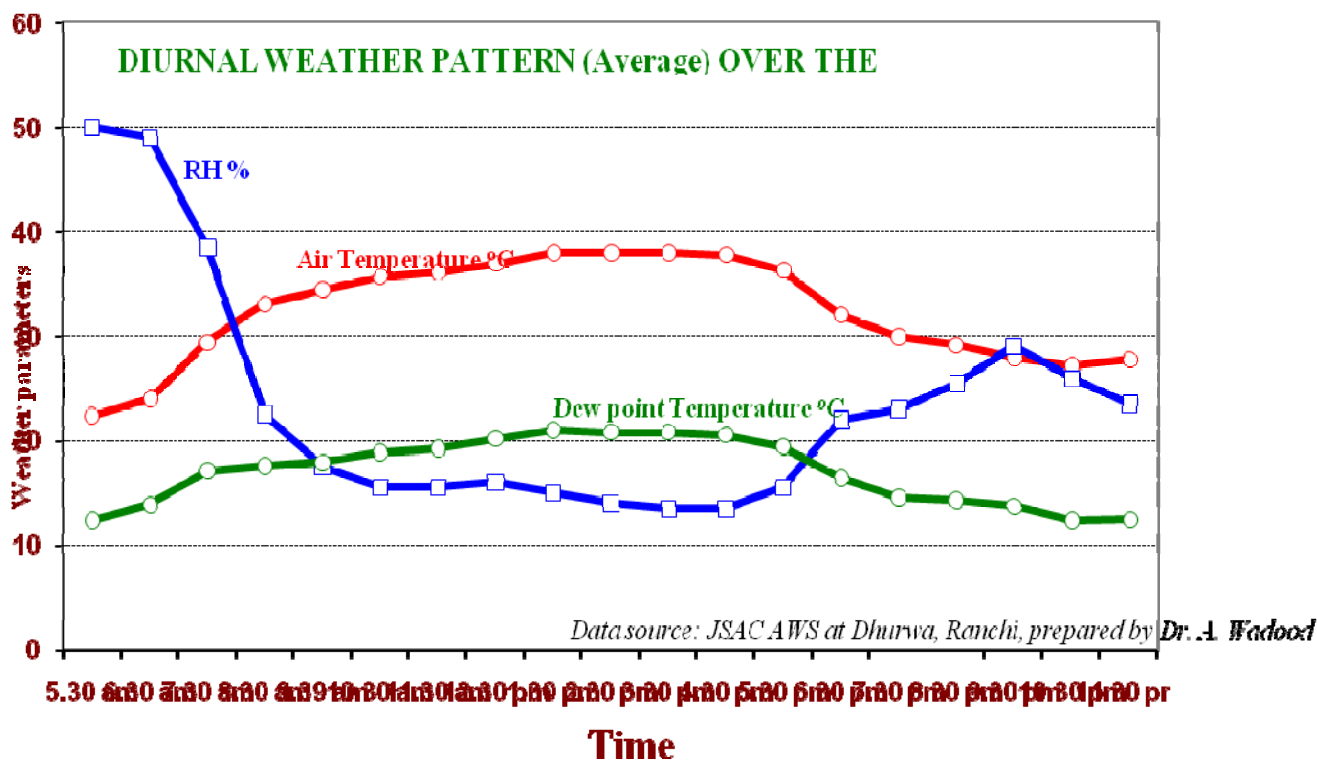




drops gradually and the air becomes more and more humid with the same preexisting amount of water vapor, already contained in it. The moment temperature drops to Dew Point, RH becomes 100%. Any further fall in temperature will cause condensation of water vapor into liquid water which appears on the surfaces of grasses, leaves and others as dew looking as a galaxy of pearls. However, if the RH in the air is low, the gap between current and dew point temperatures will be wider with lesser possibility of attainment of dew point or dew formation. Little amount of dew formation would naturally put least impact on the pitch behavior. But at high RH levels like 90% and above more water droplets will be deposited on the pitch and the surface will become softer than it was before, during the first session. The surface becomes softer due to the absorption of dew in to the soil. Seamers who can maintain a good seam position can exploit these favorable conditions and will get lots of seam movement off the pitch as the seam of the fresh cherry will penetrate more in to the softer pitch surface. Even after 20 to 30 over's since the air is heavy with high levels of humidity and if the bowlers can maintain a difference in surface smoothness on two halves of the ball, they can achieve more swing in the air or more reverse swing.

Example, 8 days average (22-29 April, 2014) meteorological data's available, at the JSCA International Stadium, Ranchi, during IPL 2014.

Time	T °C	RH%	DP
	22.35	50	12.35
6.30 am	24.05	49	13.85
7.30 am	29.4	38.5	17.1
8.30 am	33.05	22.5	17.55
9.39 am	34.4	17.5	17.9
10.30 am	35.7	15.5	18.8
11.30 am	36.1	15.5	19.2
12.30 pm	36.95	16	20.15
1.30 pm	38	15	21
2.30 pm	38	14	20.8
<b>During Match Time</b>			
3.30 pm	38.05	13.5	20.75
4.30 pm	37.85	13.5	20.55
5.30 pm	36.3	15.5	19.4
6.30 pm	32	22	16.4
7.30 pm	29.95	23	14.55
8.30 pm	29.15	25.5	14.25
9.30 pm	27.9	29	13.7
10.30 pm	27.2	26	12.4
11.30 pm	27.75	23.5	12.45



#### 4. Dew Effects

- Bowling:** Ball becomes wet becoming difficult to be gripped, killing the ball variations. The pitch becomes wet, ball will not get enough traction, It skids and kills the spin. Ball goes straighter and is easier to hit. Dew makes the ball shinier, irrespective of the side, affecting the contrast swing (both side polished). It is nearly impossible to get reverse swing from a wet ball due to dew.
- Batting:** It becomes easier to play shots, as the ball reaches the bat straight, without much turn and swing. The dew point is associated with relative humidity. Humidity (dew) affects the synthetic glove; the hand perspiration will not evaporate rapidly. It becomes easy for the batsman to play any shot, as the ball reaches the bat very nicely by skidding without turn and swing.
- Fielding:** The ball skids which can result in bad timing while fielding. Wet outfield is slippery, making fielding unpleasant and tough.

*Example: In November 2007 Pakistan chased 326 against India in a day and night match in Mohali. Pakistan kept wickets in hands and used Dew Factor conditions very well and chased the big total very easily.*

**Dew** is water in the form of droplets that appears on thin, exposed objects in the morning or evening due to condensation. As the exposed surface cools by radiating its heat, atmospheric moisture condenses at a rate greater than that at which it can evaporate, resulting in the formation of water droplets.

When temperatures are low enough, dew takes the form of ice; this form is called frost (frost is, however, not frozen dew). Because dew is related to the temperature of surfaces, in late summer it forms most easily on surfaces that are not warmed by conducted heat from deep ground, such as grass, leaves, railings, car roofs, and bridges.

The favorable weather conditions for dew formation are-

- 1) Cool, clear and long nights as in winter.
- 2) Light or calm air
- 3) Sufficient soil moisture,
- 4) High water vapor in the atmosphere at sunset and
- 5) Low night-time dewpoint depressions

#### 4.1 Formation

Water vapors will condense into droplets depending on the temperature. The temperature at which droplets form is called the Dew point. When surface temperature drops, eventually reaching the dew point, atmospheric water vapor condenses to form small droplets on the surface. This process distinguishes dew from those hydrometeors (meteorological occurrences of water), which form directly in air that has cooled to its dew point (typically around condensation nuclei), such as fog or clouds. The thermodynamic principles of formation, however, are the same.

According to the meteorologist Jeff Haby, Dew forms when the temperature becomes equal to the dew point. This often happens first at ground level for two reasons. First, long wave emission causes the earth's surface to cool at night. Condensation requires the temperature to decrease to the dew point. Second, the soil is often the moisture source for the dew. Warm and moist soils will help with the formation of dew as the soil cools overnight.

The cooling of warm and moist soil during the night will cause condensation especially on clear nights. Clear skies allow for the maximum release of long wave radiation to space. Cloudy skies will reflect and absorb while re-emitting long wave radiation back to the surface and that prevents as much cooling from occurring. Light wind prevents the mixing of air right at the surface with drier air aloft.

Heavier dew will tend to occur when the wind is light as opposed to when the wind is strong. Especially when soils are moist, the moisture concentration will be higher near the earth's surface than higher above the earth's surface. As the air with higher moisture concentration cools, this air will produce condensation first.

Soil moisture is extremely critical to producing dew (especially heavy dew). Dry regions that have not received rain in over a week or two are much less likely to have morning dew (especially heavy dew). Once the soil gets a good soaking from a rain, it takes several days for the soil to lose the moisture through evaporation. If nights are clear after a good rain, dew can be expected every morning for the next few days (especially in regions with abundant vegetation, clear skies and light wind).

The dew point depression is important because it determines how much the air will need to cool to reach saturation. With a large dew point depression (greater than 25 units of F), quite a bit of night-time cooling will need to take place in order to produce dew. A low dew point depression with the other factors favorable for dew is more likely to produce heavy dew. Dew recharges the soil moisture and limits evaporation from the soil during the time the dew is forming.

Sufficient cooling of the surface typically takes place when it loses more energy by infrared radiation than it receives as solar radiation from the sun, which is especially the case on clear nights. Poor thermal conductivity restricts the replacement of such losses from deeper ground layers, which are typically warmer at night.

Preferred objects of dew formation are thus poor conducting or well isolated from the ground, and non-metallic, while shiny metal coated surfaces are poor infrared radiators. In order to explain and define the dew point temperature, it is necessary to understand some basics about the humidity and relative humidity.

The amount of water vapor in the air is often expressed as absolute humidity. The total amount of water that the air can hold is dependent on the air temperature. The absolute humidity indicates the amount of water in a certain volume of air at a certain temperature and is subsequently expressed in  $\text{g/m}^3$  at  $x$  degree C. As the temperature of the air increases, the volume of water in the air can hold on increases, as shown in the table below –

Temp. (°C)	Max Water Vap ( $\text{g/m}^3$ )	Temp. (°C)	Max Water Vap ( $\text{g/m}^3$ )
0	4.8	25	23
5	6.8	30	30.4
10	9.5	35	39.6
15	12.8	40	51.1
20	17.3	45	65

The more commonly used relative humidity is the amount of water in the air expressed as a percentage of the maximum amount of water that the air can hold at a given temperature. The relative humidity is the ratio of water vapor content (amount of water vapor actually in the air) compared to the water vapor capacity (max. amount of water vapor the air can hold), at that particular temperature. Saturated air at a given temperature can be referred to as a 100 % relative humidity.

$$\text{Relative humidity (\%)} = \frac{\text{Water vapor content (gr/m}^3\text{)} @ 100\%}{\text{Maximum water vapor content (gr/m}^3\text{)}}$$

If we say that the relative humidity is 50 %, this indicates that the air is holding half of its maximum possible amount of moisture at a given temperature. If we increase the temperature, the maximum amount of moisture the air can hold will increase. Since the actual water content will not change, this means the relative humidity will decrease.

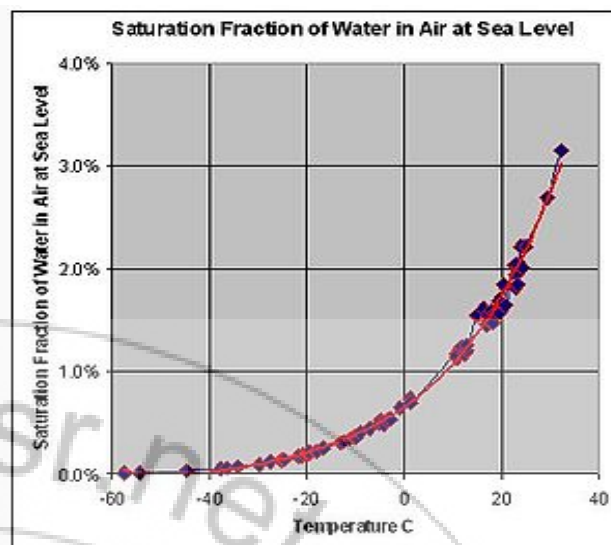
In case the temperature drops, then the relative humidity will increase ultimately to the level where the maximum concentration will be achieved ; 100 % relative humidity. Further reduction of the temperature will force the water to condense and water droplets (dew/ fog) will form indicating that the dew point has been reached. The dew point, or the temperature at which condensation occurs, depends on the amount of water vapor in the air.

The dew point temperature is the temperature to which air must be cooled for saturation (100% relative humidity) to occur, provided there is no change in water content. The dew point temperature is an important measurement used to predict the formation of dew and fog. The higher the temperature, the greater the amount of moisture the air holds as water vapor. The lower the temperature, the less the amount of moisture the air can hold. So the moisture is released at a temperature we call the Dew point. Dew point is the temperature at which the air becomes cool enough that the moisture in the air is released. The air can only hold a certain amount of moisture. The cooler the air gets, the capacity for it to hold water in the form of water vapor reduces, and it has to let the water to condense.

If the dew point temperature and the air temperature are close together in the late afternoon when the air begins to turn colder, fog is likely to develop in the night. The dew point is also a good indicator of the air's actual water vapor content, unlike the relative humidity, which is air temperature dependent.

#### 4.2 What is the Dew Point Temperature?

The dew point temperature is the temperature at which the air can no longer "hold" all of the water vapor which is mixed with it, and some of the water vapor must condense into liquid water. The dew point is always less than (or equal to) the air temperature. If the air temperature cools to the dew point, or if the dew point rises to equal the air temperature, then dew, fog or clouds begin to form. At this point where the dew point temperature equals the air temperature the relative Humidity is 100 %.



This graph shows the maximum percentage, by mass, of water vapor that air at sea-level across a range of temperatures can contain.

#### 4.3 Data source – Wikipedia, the free encyclopedia

At a given temperature but *independent* of barometric pressure, the dew point is a consequence of the absolute humidity, the mass of water per unit volume of air. If both the temperature and pressure rise, however, the dew point will increase and the relative humidity will decrease accordingly. Reducing the absolute humidity without changing other variables will bring the dew point back down to its initial value. In the same way, increasing the absolute humidity after a temperature drop brings the dew point back down to its initial level. If the temperature rises in conditions of constant pressure, then the dew point will remain constant but the relative humidity will drop. For this reason, a constant relative humidity (%) with different temperatures implies that when it's hotter, a higher fraction of the air is water vapor than when it's cooler.

#### 4.4 Measurement

A classical device for dew measurement is the drosometer. A small, artificial condenser surface is suspended from an arm attached to a pointer or a pen that records the weight changes of the condenser on a drum. Besides being very wind sensitive, however, this, like all artificial surface devices, only provides a measure of the meteorological potential for dew formation. The actual amount of dew in a specific place is strongly dependent on surface properties. For its measurement, plants, leaves, or whole soil columns are placed on a balance with their surface at the same height and in the same surroundings as would occur naturally, thus providing a small lysimeter. Due to its dependence on radiation balance, dew amounts can reach a theoretical maximum of about 0.8 mm per night; measured values, however, rarely exceed 0.5 mm.

#### 4.5 Calculating the Dew Point

A well-known approximation (but complex formula) used to calculate the dew point,  $T_{dp}$ , given just the actual ("dry

bulb") air temperature,  $T$  and relative humidity (in percent),  $RH$ , is the Magnus formula:

$$\gamma(T, RH) = \ln \left( \frac{RH}{100} \exp \left( \frac{bT}{c+T} \right) \right)$$

$$T_{dp} = \frac{c\gamma(T, RH)}{b - \gamma(T, RH)}$$

#### 4.6 Simple Approximation

There is also a very simple approximation that allows conversion between the dew point, temperature and relative humidity. This approach is accurate to within about  $\pm 1^\circ\text{C}$  as long as the relative humidity is above 50%. If you are interested in a simpler calculation that gives an approximation of dew point temperature if you know the observed temperature and relative humidity, the following formula was proposed in a 2005 article by Mark G. Lawrence in the Bulletin of the American Meteorological Society:

$$T_d = T - ((100 - RH)/5)$$

Where  $T_d$  is dew point temperature (in degrees Celsius),  $T$  is observed temperature (in degrees Celsius), and  $RH$  is relative humidity (in percent). Apparently this relationship is fairly accurate for relative humidity values above 50%. This can be expressed as a simple rule of thumb:

*For every  $1^\circ\text{C}$  difference in the dew point and dry bulb temperatures, the relative humidity decreases by 5%, starting with  $RH = 100\%$  when the dew point equals the dry bulb temperature.* For example, a relative humidity of 100% means dew point is the same as air temp. For 90% RH, dew point is 3 degrees Fahrenheit lower than air temp. For every 10 percent lower, dew point drops 3  $^\circ\text{F}$ .

#### 4.7 Control Measures

Though dew is a desired diurnal climatic variation which recharges the atmospheric and soil moisture levels (through SPAC – Soil Plant Atmospheric Continuum). It cannot be eradicated above the cricket pitch and outfield at the time or before the match but it can be minimized by adopting the following measures –

1 – **Chemical measures** – Foliar spray of APSA- 80 or Active 80 solely or along with the fertilizers, insecticides, pesticides or herbicides helps to minimize the effect of dew just 3-4 days before the match.

**APSA-80 or Active- 80** is an “All Purpose Spray Adjuvant” which on mixing with insecticides, fungicides, herbicides and defoliators increases their efficacy. As a result of that, the crops, fruits and vegetables are better protected from diseases, pests and unwanted herbs, resulting in more productive yield. This adjuvant is 80 % of active ingredients and can be mixed with in any solution to improve its performance many times.

APSA-80 or Active is neither an insecticide nor a fertilizer. It is an adjuvant that enhances the performance of the insecticides and fertilizers and also helps the water or solution to penetrate deeper.

Dew has spherical form due to a physical phenomenon called surface tension. As the attraction between water and greasy grass surface is stronger than the attraction between water and water, the water will tend to remain as a spherical droplet on the greasy plane grass surface. One can make dew droplets to drop from leaf blade by cutting the natural grease formed on grass surface by using surfactants or adjuvant like "ASPA-80"; or in other words by reducing the surface tension of dew droplets.

### 5. How Does APSA-80 Works?

It contains special element “Non Ionic Surfactants” that breaks the surface tension of the water. These surfactants work on the surface of water droplet to reduce its tendency to bead up pulling the water and wax on the leaf surface together, reducing the water’s surface tension and causing the water droplet spread out. When the water used in pesticide sprays spreads out more evenly, the result is much better pesticide coverage. Adding **APSA-80** helps insecticides, defoliators and foliar fertilizers to penetrate the surface of the leaf faster and more evenly.

#### 5.1 How to use APSA-80?

##### a) With Insecticides, Fungicides, Foliar Fertilizers’ and Defoliators

- Prepare a solution of insecticide/fungicide/foliar fertilizer/defoliator with water. Follow the mixing instructions recommended by the manufacturer.
- Mix 5 ML of APSA-80 (1/4 capful) per 15 lit of pesticide/foliar solution.
- Spray normally on the crop.

##### b) With Post-Emergent Herbicides:

- Make a solution of herbicide to be used with water in the spray tank. Follow the mixing instruction recommended by the herbicides manufacturer.
- Mix 20 ML of APSA-80 (1 capful) per 15 lit of herbicides solution.
- Spray normally on the crop.

##### c) For Use as an Irrigation Aid in cricket outfields -

- Mix 160 ML of APSA-80 (8 capfuls) in at least 80 lit of water per acre. The dosage of APSA-80 will remain 160 ml per acre of land even if the water required is more than 80 lit to cover an acre of land.
- About 12 hours before irrigating, spray this mixture of APSA-80 and water directly on the entire land area which is to be irrigated. Spray directly on the soil.
- Let the water flow into the land see how it penetrate the soil better and also spreads better.
- The above mentioned spray of the APSA-80 will remain effective about 4 weeks. Repeat the above steps for irrigation after a month.

- Increases water penetration- gets more water into the soil. Also aids irrigation by reducing run-off; saves water.
- Aids irrigation by increasing rate at which water soaks into soil; promotes more efficient water usages.
- Breaks down surface tension of water allowing better penetration of leaves.
- Helps keep spray equipment clean and prevent closed nozzles-reduces down time.
- Non-corrosive to equipment.
- Biodegradable.

### 5.2 Mechanical or Cultural measures

- 1) Don't irrigate the outfield at least 3 to 4 days before the match as the fully or less saturated outfield soil provides enough moisture through the process of evapo-transpirational and radiational cooling effect leading in achieving the dew point earlier.
- 2) To control the cooling effect due to transpiration through outfield grasses cut it to minimum possible as dew is mainly formed on the leaf blades due to evaporative and transpirational cooling effect. Mowing at lower height will reduce the leaf area index thereby reducing the impact of dew.
- 3) Use narrow leaved outfield grass variety with lesser number of stomata cell openings to minimize the cooling effect on leaf sheaths due to transpiration. Also, use shallow rooted grass variety for the outfield as it will absorb lesser water from the surface and sub-surface layer thereby controlling the cooling effect due to transpiration.
- 4) Frequently mow and dethatch the outfield so as to have lesser and uniform density of grass. Dead, decaying and unwanted grass also acts as a source of dew formation on the outfield. Also mow and dethatch the outfield even after boundary area as unattended thick grasses along with the thatches beyond the boundary acts rich source of moisture deposited due to dew.
- 5) The outfield and the sub-soil beneath should be of coarse textured with high water percolation rate and low water holding capacity as low water will be available in the root zone of the outfield grasses there by controlling the cooling effect due to evapo-transpiration and attaining the dew point early.
- 6) A good underground drainage system in the pitch and outfield should be there as to flush out the excess gravitational water available in the grass root zone and thereby reducing the effect of radiational, evaporative or transpirational cooling effect. Coarse textured outfield soil with low water holding capacity will have much more capacity to absorb the dew droplets as compared to the fine textured soil.
- 7) Keep the outfield free from weeds as these are generally broad leaved, deep rooted and competes more in pumping out water from the root zone further adding much cooling effect by transpiring more.
- 8) If it is really required to play D/N matches we can change timings on both ODI and T20 matches by starting the play little early and finish it latest by 800 PM (in humid nights). If the RH is less than 80% during the night we can continue the play until late night. However, lesser the RH values safer will be the game.

### 5.3 Artificial harvesting

Large scale dew harvesting systems have been made by Indian Institute of Management Ahmedabad (IIMA) with the participation of the International Organization for Dew Utilization (OPUR) at coastal semi arid region Kutch. These condensers can harvest more than 200 liters (on average) of dew water per night for about 90 nights in the dew season October-May. The research lab of IIMA has shown that dew can serve as a supplementary source of water in coastal arid areas.

### 6. Conclusions

Though Dew formation is a diurnal natural phenomenon (just opposite to the evapo-transpiration during the day time) its effect cannot be eradicated but can be minimized. Just by having scientific know how and approach over the long prevailing traditional mindset of tackling the menace of adverse weather conditions. Dew cannot be eradicated at the time of match as it is a usual natural phenomenon occurring throughout the year which is beneficial for the plants apart from rain. It is the natural source of water available to the plants essential for the plants by the Mother Nature. It's only a curse on the match days as it nearly kills the ball and affects all forms of cricket except batting. Its impact on Day and Night matches cannot be eradicated but can be minimized by the help of above mentioned mechanical, cultural and chemical means only.

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