OBSERVATION OF WEATHER INSTRUMENTS

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Introduction

Earth surface and its surrounding is divided into three portions viz. Lithosphere (solid portion), Hydrosphere (liquid portion) and atmosphere (gaseous portion). Weather and climate and weather instruments are related to the gaseous portion of the earth i.e. to the atmosphere.

Weather: It is the day to day change or state of the atmosphere in regard to atmospheric pressure, rainfall, temperature, relative humidity etc. on a particular place related to the short term changes of the weather elements.

Climate: It may be defined as the aggregate of atmospheric conditions (weather conditions) over a long period of time.

Weather Elements and Weather Instruments:

Crop production is directly influenced by weather elements. The elements, which influence the crop directly (temperature, rainfall, relative humidity, wind, sunshine etc.) are known as weather elements. The instruments, which are used to determine the state of the weather elements of a particular time of a particular place is known as, weather instruments. Weather instruments, which are generally used/set up at the meteorological stations, are enlisted below:

1) Maximum & minimum thermometer
2) Hygrometer
3) Rain Gauge
4) Barometer
5) Anemometer
6) Wind Vane
7) Sunshine recorder

1. Maximum and minimum thermometer:

It is used in recording maximum and minimum temperature of a particular day of a particular place.

Structure: This instrument is mainly a 'U' shaped glass tube of which one upper portion is ended in a spherical bulb and another portion is ended in a cylindrical bulb. The 'U' shaped glass tube is filled with mercury in the middle position and alcohol in the two terminal positions. Two indexes are placed on the two upper margins of the mercury column and two scales are set up at the two opposite sides of the glass tube of which one indicates maximum temperature and another indicates minimum temperature. All these structures are set up in a plastic frame. This thermometer is known as Six's maximum and minimum thermometer after the name of the inventor.

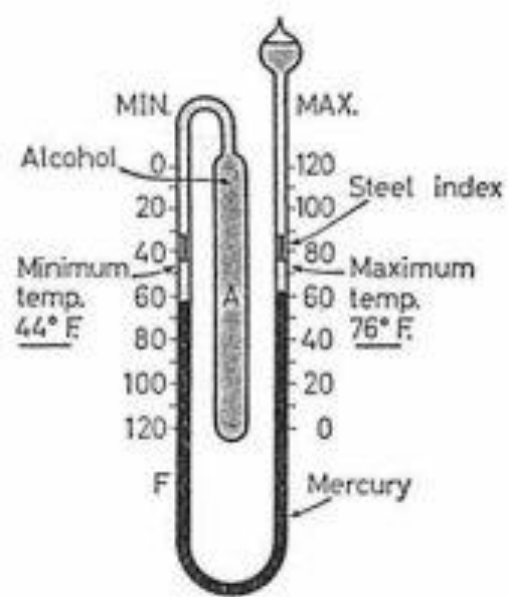

Fig. maximum and minimum thermometer

Working principle: When temperature increases the volume of the alcohol increases which press the mercury column of the glass tube of the minimum thermometer side and the index rises of the maximum thermometer side, and vice-versa. The position of the indexes of maximum and minimum thermometer indicates maximum and minimum temperature, respectively.

Importance: Among the weather elements temperature is an important factor for crop production. Temperature influence crop production by influencing germination of seeds, seasonal and regional distribution of crops and by helping the process of photosynthesis. Every crop has a maximum and minimum temperature for the vegetative and reproductive development. So it is necessary to know the maximum and minimum temperature of a locality. This is why, the instrument maximum and minimum thermometer is important in agriculture.

2. Hygrometer

It is used ion measuring the atmospheric humidity of a particular day of a particular place. Generally dry and wet bulb thermometer is used in measuring relative humidity.

Structure: Dry and wet bulb hygrometer consists of two thermometers named, dry bulb thermometer and wet bulb thermometer. The wet bulb thermometer is connected with a water pot by wet cotton. All these structures are set up in a wooden box named Stevenson's screen.

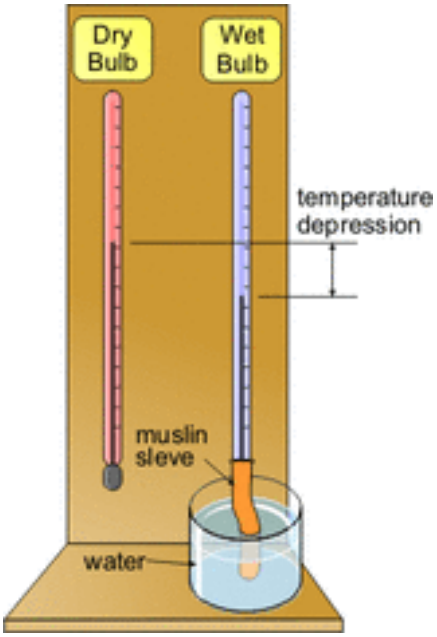

Fig. Hygrometer

Working principle: This instrument does not directly measure relative humidity. By this instrument, dry bulb thermometer reading and wet bulb thermometer reading is recorded and their difference is used. To calculate the atmospheric relative humidity, amount of water vapor in air and the amount of water vapor required to saturate the same volume of air at the same temperature are looked up from a correction chart named "Regnault chart" in respect of dry bulb thermometer reading using their (dry bulb and wet bulb thermometer reading) differences. Then, relative humidity is measured by the following formula:

$$\% \text{ RH} = \frac{V_a}{V_s} \times 100$$

Where, V_a = Amount of water vapor in a certain volume of air at a certain temperature

V_s = Amount of water vapor required to saturate the same volume of air at the same temperature

Importance: Relative humidity is also responsible for regional and seasonal distribution of crops. So it is necessary to determine the atmospheric relative humidity. This is why, this instrument is important in agriculture.

3. Rain Gauge:

The instrument by which amount of rainfall is measured is known as raingauge. Another name of this instrument is Symon's rain gauge.

Structure: It is a simple instrument. It is a cylinder of certain diameter upon which a funnel of the same diameter is set up inside the cylinder, a bottle is placed under the funnel.

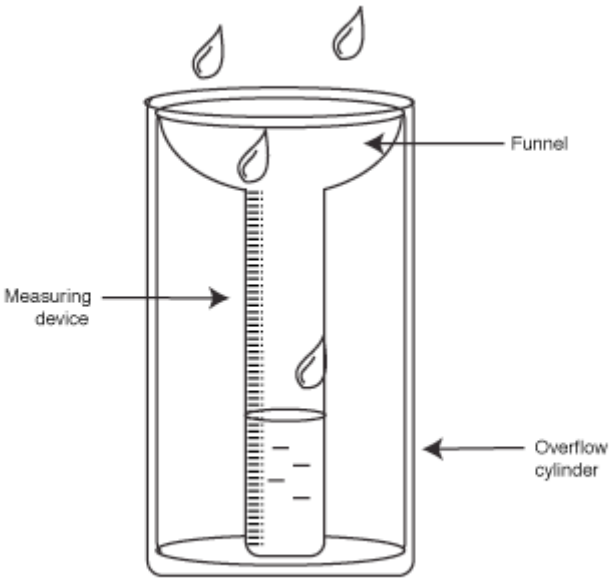

Fig. Rain Gauge

Working Principle: Water is collected in the bottle. The collected rainwater is measured by a measuring cylinder and the amount of rain fall is measured by the following way:

Let, Diameter of the raingauge cylinder = D
Height of rainwater in raingauge = H

$\therefore$ Volume of rainwater in raingauge = $\pi \times (\frac{D}{2})^2 \times H$

$$= \frac{\pi D^2 H}{4}$$

Again, Let, volume of rain water in measuring cylinder = v

Now, the volume of rain water in rain gauge will be equal to volume of water in measuring cylinder.

$$\therefore \frac{\pi D^2 H}{4} = V \text{ or, } H = \frac{4V}{\pi D^2}$$

So, amount of rainfall will be = $\frac{4V}{\pi D^2}$, if the diameter of measuring cylinder and height of rainwater in measuring cylinder are d & h respectively, the volume of rain water in measuring cylinder v will be =

$\pi \times (\frac{d}{2})^2 \times h = \frac{\pi d^2 h}{4}$, Then H will be = $4 \times \frac{(\pi d^2 h)/4}{\pi D^2}$ or H = $\frac{d^2 h}{D^2}$

Importance: Rainfall influence crop production by influencing regional and seasonal distribution of crops and by helping in proper timing of irrigation & drainage. Every crop has its certain locality. So, this instrument is important in agricultural point of view.

4. Barometer

It is an instrument, which is used to measure the atmospheric pressure. Generally, Fortin's barometer is used for this purpose.

Structure: It is mercury containing glass tube lying inside a metallic tube. This Tube lies on a mercury container. A linear and a vernier scale lies above the mercury column near the glass tube.

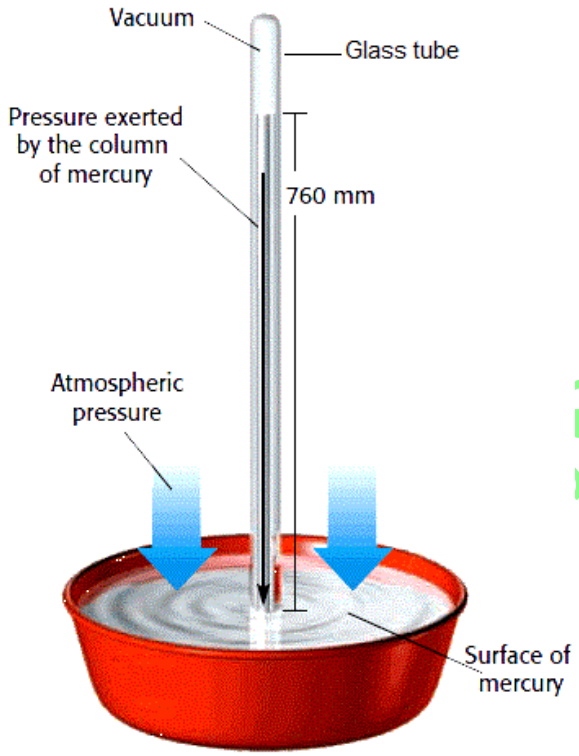

Fig. Barometer

Working Principle: The atmospheric pressure is measured by measuring the height of the mercury column through linear and vernier scale. When atmospheric pressure decreases the height of the mercury column decreases and vice-versa. Generally, it is considered that the atmospheric pressure at sea level (at 0^{o} temperature) is 760mm of mercury column.

Importance: As water vapor is lighter than air, the increase of water vapor in air decrease the atmospheric pressure and vice-versa. The decrease of atmospheric pressure indicates the probability of rain, cyclone etc. So, this instrument is necessary in agriculture to forecast on this natural aspect.

5. Anemometer

It is an instrument by which wind speed is measured. Generally, Robinson's cup anemometer is used in the meteorological stations for this purpose.

Structure: In this instrument, three aluminum cups are attached to three iron-roads, which are placed on the accel. This accel is attached to a dial at the bottom by a gear system.

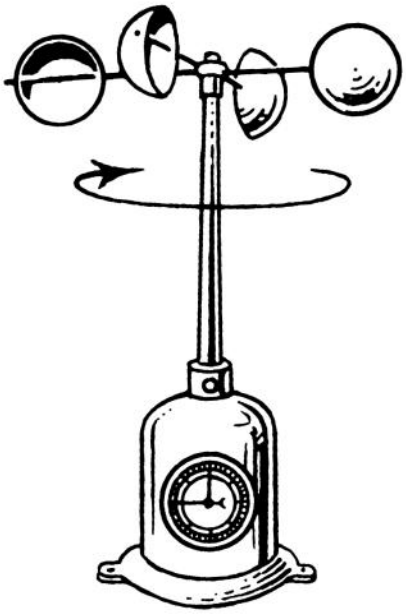

Fig. Anemometer

Working Principle: When wind blows, the aluminum cups start to move. The increase of wind speed increases the movement of cups and simultaneously index of the dial indicates higher reading. The wind speed is then measured by the position of the index of the dial.

Importance: It is also important in agriculture to forecast of rainfall, and wind speed etc.

6. Wind vane:

This instrument is used to detect the direction of wind.

Structure: This instrument consists of an arrow, which is placed on a ball bearing system and able to move freely. Four road-like structures are also placed below the arrow which is indicates the north, South, East and west direction.

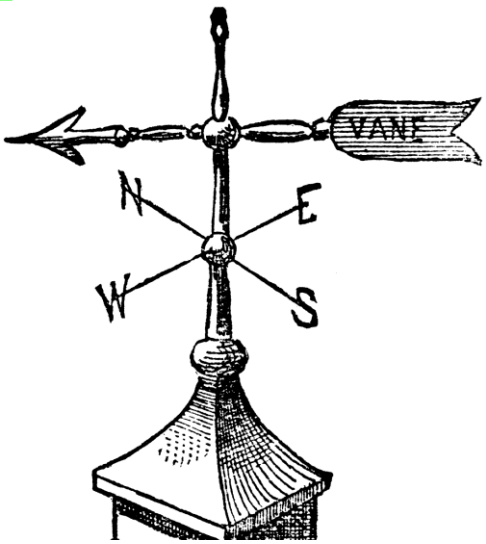

Fig. Wind Vane

Working Principle: The position of the arrow indicates the direction of wind. The arrow starts to move by wind and when the terminal point of arrow lies at the direction of wind blowing it remains static. The direction is detected by road like structures. When the terminal point of the arrow remain in the east, it indicates that wind blows from the east to the west and vice-versa.

Importance: Wind greatly influenced on fertilizer and pesticide application. Generally, pesticide should not be used from opposite direction of wind. So farmers should know the direction of wind before fertilizer and pesticide application. So, this instrument is important in agriculture.

7. Sunshine Recorder

This instrument is used to record the duration of sunshine hour in a day.

Structure: This instrument consists of a big spherical lens, which is set up in a frame. A paper chart is placed under the lens.

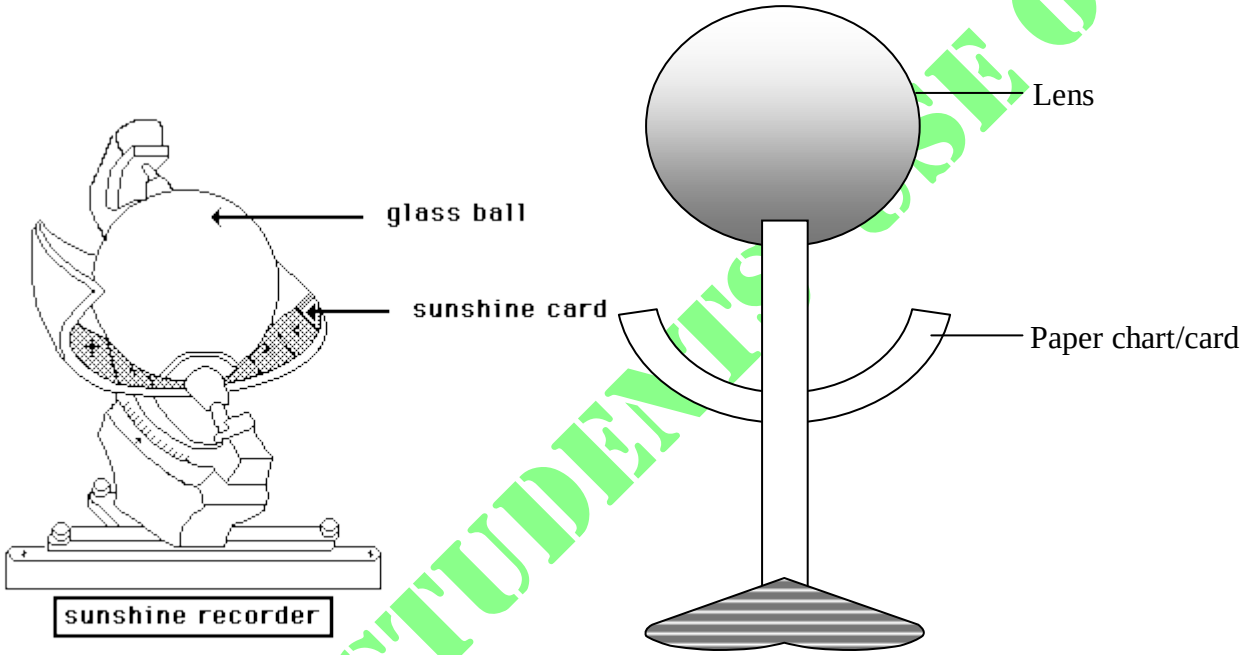

Fig. Sunshine Recorder

Working Principle: When sunshine present, the paper chart is burned by heat passing through the lens. But, in absence of sunlight the paper chart become intact. We can record the duration of sunshine hour from the paper chart by using measuring the burned portion of the paper chart.

Importance: Light influenced on growth and seed production of crops. On the basis of the duration of sunlight we have to select short and long day plant for a certain locality. This is why, this instrument is necessary in agriculture.

Regnault Chart

Dry bulb thermometer reading	Difference between dry bulb and wet bulb thermometer						
	0	1	2	3	4	5	6
	Amount of water vapor in air (ml)						
10	9.2	8.1	7	6	5	4	3.1
11	9.8	8.7	7.6	6.5	5.5	4.5	3.5
12	10.5	9.3	8.2	7.1	6	5	4.0
13	11.2	10.0	8.9	7.6	6.5	5.5	4.5
14	11.9	10.7	9.4	8.3	7.1	6.1	5.0
15	12.7	11.4	10.1	9	7.8	6.6	5.5
16	13.5	12.2	10.9	9.7	8.4	7.3	6.0
17	14.4	13	11.7	10.4	9.1	8	6.1
18	15.4	13.9	12.5	11.2	9.9	8.6	7.5
19	16.3	14.9	13.4	12	10.7	9.4	8.1
20	17.4	15.9	14.3	12.9	11.5	10.2	8.8

Problem 01:

If, the diameter of rain gauge and measuring cylinder is 20 cm and 5 cm respectively and the height of rainwater in (Measuring cylinder) is 15 cm, calculate the amount of rainfall.

Solution:

We know,

Rainfall, $H = \frac{d^2 h}{D^2}$

$= \frac{5^2 \times 15}{20^2}$

$= 0.9375$

Here,
D = 20 cm
d = 5 cm
h = 15 cm
Rainfall, H = ?

Result: The amount of rainfall is 0.9375 cm

Problem 02:

If, the DBT and WBT readings are 12°C and 10°C, respectively. Find out the Relative Humidity (% RH).

Solution:

We know,

% Relative Humidity (RH) $= \frac{V_a}{V_s} \times 100$

$= \frac{8.2 \times 100}{10.5}$

$= 78.095$

Here,
$V_s = 10.5$
$V_a = 8.2$
RH = ?

Result: The percent of relative humidity is 78.095