Agricultural Meteorology **Dr. AMJED ALI**

The section of meteorology that concern with the production of crop is called agricultural meteorology.

Meteorology is mainly concerned with weather and climate. All other features that is rainfall, wind, humidity and temperature are directly related to weather and climate.

Agriculture is an industry, which is open to natural calamities and almost all of its success depends on natural phenomena. Therefore, the full knowledge of meteorology is very essential for running this industry on sound footing.

Weather

It is state of atmosphere at any time. It changes from time to time.

It is the combined effect of such conditions that is;

heat or cold,

wetness or dryness,

wind or calm,

clearness or cloudiness.

Climate: Aggregate of atmospheric conditions over a long period of time is called climate.

Atmosphere: A deep blanket or mantle of gasses which entirely envelops the earth. It is a mixture of gasses and its composition is more or less uniform throughout the world, variations are there.

Gasses

Nitrogen	78 % by volume
Oxygen	21 %
Minor gases	1 %

Minor gases are:

Argon	0.94%
Co_2	0.04%

Hydrogen, neon, helium, xenon etc. 0.01%

Moisture

It is most subjected to variation. It is percent is very small quantities in desert air and in abundance up to a maximum of 4% in humid areas.

Impurities in the atmosphere

Bacteria, spores of fungus, fine soil particles, smoke, CO_2, CO, CO_2, NO, N_2O.

Importance of atmosphere or climate

Climate impacts: Unfavorable climatic conditions such as heavy rains, floods and droughts adversely affects agricultural productivity. About 20% reduction in crop productivity occurs due to adverse climatic situations in Pakistan. The state of atmosphere and the changes it undergoes profoundly influences all physical, chemical and biological activities over the earth. Thus it regulates the living conditions of plants, their grow and multiplication. The living organisms are able to adjust themselves to the prevailing state of the atmosphere to a certain extent. Those plants survive alone that adapt themslve to a particular state of atmosphere, the other get extinct. That is how special flora and fauna have developed in the different climatic zones of the world, as in the tropical, temperature and arid regions. Tropical regions get abundant heat and rainfall, so natural vegetation is of luxuriant type. Whereas in desert plant growth is poor due to low rainfall.

Climate influence crop growth profoundly. Fore example plants of tropical regions get abundant heat and high rainfall therefore plants of this regions grow profusely. Low rainfall results in poor plant growth as in desert regions. Wheat growth best in sub-cropical and temperate climate. Sugarcane growth occurs successfully in coastal, temperate and sub-tropical climate.

Classification of climates

A. Classification based on solar radiation.

1. Tropical climate

Climate where average monthly temperature changes little during the year and length of the day changes only slightly at different times of year. This climate is sever in nature due to intense heat of sun and bears very high rainfall, cloudy

weather and humidity. Soil is rich and fertile due to the presence of more organic matter. Bacterial activities are high. N.W.F.P, Rawalpindi, Jhelum.

2. Temperate climate

Climate with warm summers with long day and cool winter with long nights. It bears moderate temp and enough rainfall. Frost and comparatively low towards interior.

3. Sub-tropical

Between tropical and temperate climate.

4. Polar climate

This climate is found on both poles of the earth. Highest temp does not exceed 50F. very severe cold all year long fogy and snowy weather prevails always.

B. Classification based on geographic conditions

1. Marine climate

Climate of sea and marine is called marine climate. Large amount of clouds and rains are found. Very little change in temperature and season.

2. Coastal climate

Climate which prevails near the cost of ocean. Hot humid during day and cold dry at night. Winds remain blowing always during day. Season remains mild all the year long.

3. Continental climate

There is a great variation in temperature i.e. maximum temp goes very high and minimum too low. June, July are hottest and Dec, Jan are coldest months. Dusty air, high evaporation and low rainfall.

4. Mountainous climate

Climate found in hilly areas. Pressure and temp remain low air is pure, clean and thin with heavy rains especially during summer. Winter is severe with heavy snow but summer is mild and pleasant.

5. Desert climate

This is extreme type of continental climate found in desert. It is dusty and free from bacteria. There is high wind velocity, high temp and low vegetation.

6. **Monsoon climate**

Climate found during monsoon season i.e. July-August with fairly good rainfall. Very suitable for plant growth.

Factors affecting climate

1. **Altitude (Height from sea level)**

In elevated region, air is thinner and does not receive much heat as there are less dust particles to intercept sunrays and thus climate is cooler. Murree is cooler than Faisalabad.

2. **Latitude (Northern or Southern distance from equator)**

Places near the equator are always hot as the sunrays fall.

3. **Distance from sea**

Plant near the sea are perpendicular during the year. Places which are away from the equator (near poles) are cooler e.g., Indo-Pak is warmer than China and China is warmer than Japan.

4. **Position and direction of mountains**

The interception of warm and moist winds by high mountains cause heavy rainfall on one side while the other side may remain dry.

5. **Forests**

They affect climate by causing more humidity and rainfall.

6. **Slope of the land**

If the slope of the certain place is toward sun, the climate of that place will be warm because the sunrays fall perpendicular. When sunrays fall parallel, climate is cool.

7. **Winds**

Moist wind cause rain and make the atmosphere cool.

8. **Rainfall**

Countries receiving more rainfall have moist and cool climate whereas the country receiving low or no rainfall possess dry and hot climate.

Seasons of Pakistan

1. Rabi season (Winter): it start from Oct-Nov and goes upto April-May.
2. Kharif Season (Summer): It start between April, June and ends in Oct-Nov.
3. Zaid Rabi (Spring): It start late in Rabi (Feb-March) season and ends in early Kharif season (May-June).
4. Zaid Kharif (Autumn): It starts late in Kharif season (Aug-Sept) and ends in early Rabi season (Nov-dec).

Kharif Season

Most of the rainfall (about 70%-80% of the total) is received during monsoon (July-August). The monsoon is the most important climate phenomenon of this season. From May to September, it blows across the Arabian sea from the south-west to the North-East, regularly reaching speeds of 50 kg per hour. As the wind blows, it pick up and transports evaporated ocean water which is dumped as torrential rain on Sri Lanka, Pakistan, India and other countries as far noth as the Himaliyan Mountains. Summer months except in the mountains areas, are very hot with a maximum temperature of more than 50^0Cwith average temperature ranges from 322-46^0C. Plants are flexible and respond to different environmental conditions.

Hot desiccating winds and sand strom blow from April to August with a velocity ranging from 8 to 80 km/hour. Intensity and runoff of summer rainfall is more but absorption/penetration of water is less. Relative humidity is the highest during summer with August as a humid month.

Rabi Season

20 to 30% of the total rainfall is received during winter through occasional shower. Intensity and runoff rainfall is less and more water absorption. Winter months are mild and plains having is low temperature as 2 to 5^0C with wide spread forest for a days. Temperature is extremely severe in hilly areas where the mercury falls below 0^0C oftenly relative humidity falls moderately.

Impact on crop growth

Agriculture is rain fed (Barani areas) depends on summer rains. Rainfall water is conserved for growing of summer crops. If rainfall occurs at proper interval and intensity particularly at time when needed by crops, usually a good crop growth and yield is obtained. In some areas moisture from summer rain is conserved for winter crops. Frequent and intensive rainfall causes loss of soil by erosion, uprooting of young crop plants, their burring and lodging. Severe winds also result in above cited damages to the crops. During winter rainfall is very much effective for successful cultivation of crops in barani and irrigated areas.

Rainfall in irrigated areas during summer is also useful for crops if occurs at proper interval and proper amount. Too much rainfall sometimes at showing of cotton reduces the germination. Whereas during growing season, heavy rains cause excessive vegetative growth, more humidity thereby, increasing the chance of insect attack. But this rainfall usually favours rice and sugarcane growth. Excessive rains also result in more weed growth which compete with crop plant. Sometime rainfall occurs at harvesting of rice of picking of cotton which deteriorates the quality of crop and yield is reduced. Similarly rainfall in April-May when harvesting of wheat starts cause lodging, delay the , threshing and adversely affect the quality and quantity. Occasional occurrence of hail stroms during summer also damage the crops. Frost during December-January damage the winter fodder thereby reduced the yield.

Weather elements and plant growth

1. **Temperature**

   It may be defined as degree or amount of heat or cold.

Types

i. **Minimum temperature:** below that growth cannot occurs.

ii. **Optimum temperature:** at which maximum growth occurs.

iii. **Maximum temperature:** above which growth decreases seriously. Temperature influences growth of plant in a number of way.

1. Maximum photosynthesis takes place at 37^0C and stops at 45^0C.

   Optimum temp. for wheat growth is 25^0C, maximum 30-32^0C.

   Optimum temp. for maize growth 32^0C.

   Optimum temp. for cotton growth 33^0C.

2. High temp. increases transpiration losses and plants may suffer for water deficiency.
3. High temp. may cause desiccation of male or female part of flower which results in poor fertilization, shedding of flower may occur.
4. Excessively high temp. causes destruction of chlorophyll lot and produced a pale green to yellow discoloration.
5. During grain development high temp. causes shriveling of grains due to more water losses. The temperature, 2-4ºC warmer than normal at grain formation phase, accelerated the development as the required heat units were met immediately. The grains could not gain proper size and weight rather they were shriveled hence results in reduced yield. Early maturity did not allow the young wheat grains to grow to their normal weight, size and starch contents.
6. The occurrence of mild heat wave (13 days above normal (2-3ºC) temperatures) in early spring at reproductive stage may cause about 28% reduction in the grain yield of wheat.
7. Due to higher night temperatures, the respiration over ruled the photosynthesis causing reduction in net gain. Rice grain yield declined 10% for each 1ºC increase in minimum temperature.
8. Due to global warming, the temperatures are expected to increase over the present limits at a variable rate simultaneously the water demand of the crops will also increase. The future water requirement of the crops generally grown in different climatic zones of Pakistan taking 1ºC, 2ºC and 3ºC rise in temperature, an average increase in crop water demand 11%, 19% and 29% may occur, respectively.

2. **light**

It is a form of energy can be converted from one form of another.

i. High light is necessary for photosynthesis, the process of making food, essential for growth of plants. With certain limits the larger the amount of light a plant receives, the greater is its growth. In regions of poor sunshine photosynthetic activity and growth of plants are limited.

ii. It is essential for chlorophyll formation.

iii. It promotes of leaf expansion, stem extension, initiation of buds and flowers.

iv. Red, orange and yellow light in some seeds enhance germination of seed.

3. Humidity

Moister of the air which is in the form of water vapours is called humidity. It is that water which escapes into the atmosphere by evaporation from soil surface and transpiration from plant surface.

Types

The amount of water vapor in the air is called **absolute humidity**.

The amount of water vapor in the air as compared with the amount of water that the air could hold is called **relative humidity.** This amount of space in air that can hold water depend on the temperature and pressure

$$\text{R.H} = \frac{A.H}{S.H} \text{ X } 100$$

Effects on plant

i. High humidity of the atmosphere reduce transpiration in plants. Low humidity on the other hand increases the water requirements of crop plants by increasing transpiration. In such conditions crop growth is difficult to maintain without irrigation.

ii. High humidity may result in poor fertilization due to less pollon mobility.

iii. High humidity of the atmosphere reduce the resistance of plants to fungal discover e.g,, frequent moist periods coupled with temperature between 15 to 22^0C favour the establishment of leaf rust (brown rust) of wheat. An **increase in rainfall** in some areas, which would lead to an **increase of atmospheric humidity** and the duration of the wet seasons. Combined with higher temperatures, these could favor the development of **fungal diseases**.

4. Winds

Wind is an air approximately horizontal in motion. Wind move from high pressure zone to low pressure zone. They make the atmosphere cool, hot, moist or dry and they exert a great degree of control on climate. Winds become moist when move over larger areas of water and carry this water to lands for precipitation.

Types

a) **Regular Winds**

These are the winds, which below in regular order during specific period e.g. monsoon winds.

b) **Variable Winds**

These winds blow occasionally, e.g. cyclones.

c) Cold and Hot winds

Which blow in severe winter and summer.

Effects

i. It helps in pollination of crops.

ii. Cold winds keep down the atmospheric temperature and the reduce transpiration.

iii. Hot winds promote loss of soil and plant moisture by evaporation and transpiration, respectively and thus increasing water requirement of crops.

iv. Strong winds interfere with fruits setting and promote fruit fall in orchards.

v. Mature crops that have thin stems like wheat, rice are lodged.

vi. Strong winds pick up soil particles when land is bare and loose, and bring about soil erosion.

vii. May uproot the plants.

5. Precipitation

The amount of moisture falling on an area regardless of the physical form i.e. whether it is in liquid, vapors or froze forms.

a) Rainfall

On cooling the air water vapors held in it, fall on the ground in the form of drops, which is known as rain.

i. Rain is the only source of supply of water to crops in rain fed or barani areas.

ii. Regions with high rainfall have abundant crop growth.

iii. Deficient rains limit crop growth.

iv. It is a source of N for crop plants. During lightening energy is produced which results in splitting of H_2O in H + OH ions. These along with O_2 react with N_2

molecules to produce very small droplets of NO_3 which are brought to earth in rain. It decreases soil pH.

v. Heavy Rainfall may cause pollen shedding.

vi. They induce stagnation of water in soil and cut off aeration.

vii. Heavy rains cause leaching of soil nutrients.

viii. Heavy rains after sowing may reduce germination and during early season may cause lodging.

ix. Cloudy and rainy weather causes more vegetative growth and insect attack occurs.

b. Hail Strom

When rain drop on their way to the earth pass through a region of intense cold, they freeze and fall on the ground in the form of stones and lumps of ice called hailed storm. Falling hailstorm together around the rain drops, which also freeze, thus increases the size of hailstorms.

i. These are injurious to crops, because these destroy the standing crops fully or partially.

ii. Upset the structure of soil.

iii. Source of soil moisture

c. Snow

When the clouds ascend to intensively cold regions of atmosphere with temperature below freezing point, they freeze without passing through the liquid form and fall as snow.

i. It acts as a cover to prevent evaporation.

ii. Upon thawing it enters the soil directly to increase soil moisture for plant growth.

iii. The rapid development of spring vegetation in climates where snow accumulation is more, largely depends upon water and N supply from melting snow.

iv. As snow melt slowly in the higher altitude, it is an important source of water supply.

d. Frost

During very cold and clear nights the temperature of the atmosphere sometimes fall below zero and the excess of water vapours present condense on the earth as a frozen form of water known as frost.

i. It is harmful to standing crops greatly because it kills the growing points, buds or eyes (due to cold injury) of crops (sugarcane).
ii. Freezing and thawing action improves the structure of soil and air circulation is enhanced.
iii. Weeds are killed by frost, when buried weeds serve as manure. Beside this, food material which is taken up by weeds will remain in the soil and fertility remains conserve.
iv. Increase soil moisture.

e. Dew

At clear night grasses, flowers and leaves radiate heat more quickly than any other things and thus become very cold and their temperature becomes lower than air. When moist air touches them it is also cold and cannot hold the same amount of water vapours as before. A part of water vapour is condensed and deposited on these things in the form of water drops which are called dew.

i. It can provide a very small proportion of the water requirement of a normally growing spring plant but may of some importance to plant under water deficit.

ii. It may accelerate restoration of leaf turgor and in the morning can delay the onset of renewed stress.

f. Fog

When hot moist air comes in contact with cold air or cold water, it is cooled and some of water vapours condense around the flouting particles of dust in the atmosphere near earth. This is called fog.

g. Mist

It is identical to fog and formed in the same way. The only difference is that in mist the water particles are bigger and wetter.

i. This is harmful to crops because it will not allow the light to reach the plants and plants will not be able to make their food.

ii. Frequent mist or fog by reducing evaporation may considerably conserve the soil moisture.
iii. Decreases transpirations losses.
iv. Desert vegetation derive its water requirements from fog or mist

Higher concentrations of atmospheric carbon dioxide effects on crops

higher concentrations of atmospheric carbon dioxide affect crops in two important ways: they boost crop yields by increasing the rate of photosynthesis, which spurs growth, and they reduce the amount of water crops lose through transpiration. Plants transpire through their leaves, which contain tiny pores called stomata that open and collect carbon dioxide molecules for photosynthesis. During that process they release water vapor. As carbon dioxide concentrations increase, the pores don't open as wide, resulting in lower levels of transpiration by plants and thus increased water-use efficiency.

Rising carbon dioxide concentrations will increase plant growth. More rapid leaf area development and more total leaf area could translate into more transpiration.

Rising carbon dioxide concentrations will decrease leaf stomatal conductance to water vapor. This effect could reduce transpiration.

What is NASA

NASA stands for National Aeronautics and Space Administration. NASA was started on October 1, 1958, as a part of the United States government. NASA is in charge of U.S. science and technology that has to do with airplanes or space. NASA does a lot of different things. NASA makes satellites. The satellites help scientists learn more about Earth. NASA sends probes into space. NASA scientists study things in the solar system and even farther away. A new program will send humans to explore the Moon and, one day, Mars. NASA also shares what they learn with others. People who do not work at NASA can use NASA ideas to make new inventions. These new inventions can help make life on Earth better. NASA Headquarters is in Washington, D.C. There are 10 NASA centers across the United States.