Weather Hazards

Weather hazards are those abnormal weather conditions which are harmful for human kind. In Agrometeorology only those weather hazards are considered, which are significant for plants such as Drought, Frost, Floods, Storms, Hailstorm Thunderstorms, Heat wave, Cold wave, Tornados, Squall etc.

1. Drought: In general drought may be defined as a complex phenomenon which results from the prolonged absence of precipitation in conjunction with high rate of evaporation. This causes abnormal loss of water form water bodies, lowering of the water table and dehydration of the root zone of the soil, thus upsetting water supply to plants.

Classification of Drought

Drought can be broadly divided into three categories on the basis of impact of weather deficit.

1. Meteorological drought: It is a situation when the actual rainfall is significantly lower (25% less) than the climatologically expected rainfall (normal) over a wide area. 25-50 % Moderate Drought, >50% Severe Drought

Weather Hazards: Drought

2. Hydrological drought: It is associated with marked depletion of surface water and consequent drying up of lakes, rivers, reservoirs etc. Hydrological drought occurs when meteorological drought is prolonged.
3. Agricultural drought: It is a condition in which there is no rainfall and insufficient soil moisture availability in the root zone of the crop.

Drought Based on Environment

1. Atmospheric drought: It occurs when the rate of transpiration exceeds rate of absorption of water due to low RH, high temperature and moderate to high wind velocity, even though available soil moisture is high in the soil. The drought is temporary and reversible.
2. Soil drought: Condition when the water demand exceeds soil moisture supply (>15 hours- Permanent wilting point). It is gradual and progressive. It is highly detrimental than others.
3. Physiological drought: Even though the available soil moisture is high in the soil, the plants are not able to absorb due to a) closing of stomata because of insufficient water absorbing surface or very high atmospheric water demand and b) Low soil temp.

Weather Hazards : Drought

Drought as per time: Thornthwaite defines drought as "a condition in which the amount of water needed for transpiration and direct evaporation exceeds the amount of moisture available in the soil".

1. Permanent drought - arid climate
2. Seasonal drought - climate with annual periods of dry weather

Drought due to precipitation variability (amount):

a. Moderate drought - lower quality or yield
b. Severe drought - failure of crop.

Drought: Agriculture Impacts

Causes:

(*a*) Meteorological factors, i.e. precipitation and its intensity, air and soil temperature, solar radiation and sunshine duration and wind speed;

(*b*) Agricultural factors, i.e. the type of crop, stage of plant development and method of cultivation;

(*c*) Natural environment factors, i.e. soil, hydrology and drainage of the soil, topography and land forms; and

(*d*) Irrigation and anthropogenic factors associated with land use practices, notably deforestation and over grazing which tend to modify the surface reflectivity (albedo), surface roughness and moisture convergence.

Impacts:

(e) These affect the feedback on moisture recycling mechanisms leading to reduced evaporation and hence available atmospheric moisture required for cloud formation and precipitation.

(*f*) Shortage of food production due to crop failure;

(*g*) Shortage of fodder and drinking water for cattle, migration of livestock population and even decrease in animal population;

(*h*) Shortage of animal power for agricultural operations during the subsequent period as a result of the reduced animal population; and

(*i*) Deforestation because of increased fuel-wood needs due to the non-availability of agricultural wastes and crop residues.

Drought Alleviation

A) Strategic decisions

1) Development of reliable Drought Forecasting system
2) Rationale (judicious) land use planning
3) Crops which need a short duration to mature and require relatively less water, need to be encouraged in drought prone areas.
4) Irrigation, through canals and groundwater resources, need to be encouraged with optimum utilization avoiding soil salinity and excessive evaporation loss.
5) Varietal manipulation by adopting varieties that are drought-resistant at different growth stages, the effects of drought can be avoided or minimized
6) Ground water exploitation (judicious)
7) Soil and water conservation and management
8) Inter-cropping
9) Introduction of alternative crops / varieties
10) Afforestation

Drought Alleviation

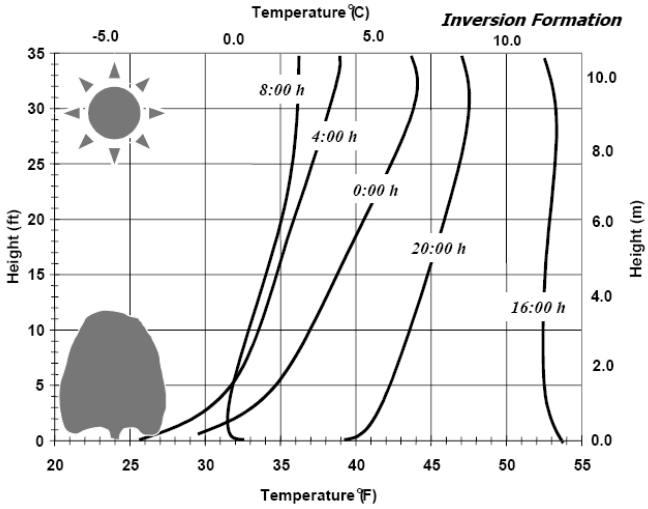
B) Tactical decisions

- Reducing the plant population,
- Reducing the fertilization
- Weed management
- Suplement irrigation
- Increase water holding capacity of soil
- Contingent crop planning with short duration and low water requirement.
- Reduce water consumption.
- Divert water from other sectors

Weather Hazards: Frost

Frost is the deposition of water below the freezing temperature on physical objects such as plants. The water vapors are directly converted into ice crystals.

Changes in temperature profile during a radiation frost night.



Frost: Protection Methods

Fost protection methods

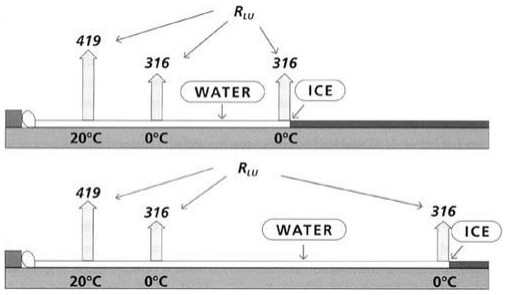
1) PASSIVE FROST PROTECTION METHODS

a) Site Selection
b) Soil Water Content
c) Ground Cover and Mulches
d) Crop Covers
e) Frost resistant crops

2) **ACTIVE FROST PROTECTION METHODS**

a) Surface Irrigation
b) Wind Machines
c) Heaters
d) Helicopters
e) Sprinklers
f) Foggers

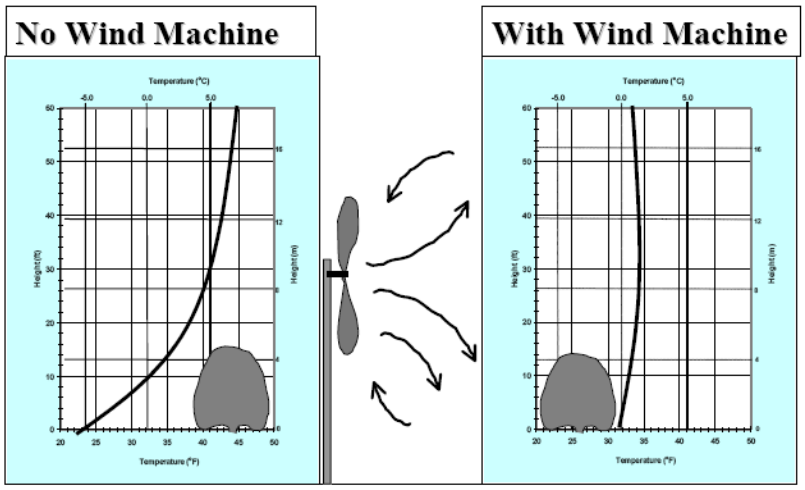
Frost: Irrigation



Process	Heat Exchange
	Calories per gram
Water cools from 20ºC (68˚F) to 0ºC (32˚F)	+20.0
Water freezes at 0˚C (32˚F)	+79.7
Ice cools from 0˚C (32˚F) to -5 ˚C (23˚F)	+2.5
Water evaporates at 0 ˚C (32 ˚F)	-597.3
Water condenses at 0 ˚C (32 ˚F)	+597.3
Water sublimates (ice to water vapor) at 0 ˚C (32 ˚F)	-677.0
Water deposits (water vapor to ice) at 0 ˚C (32 ˚F)	+677.0

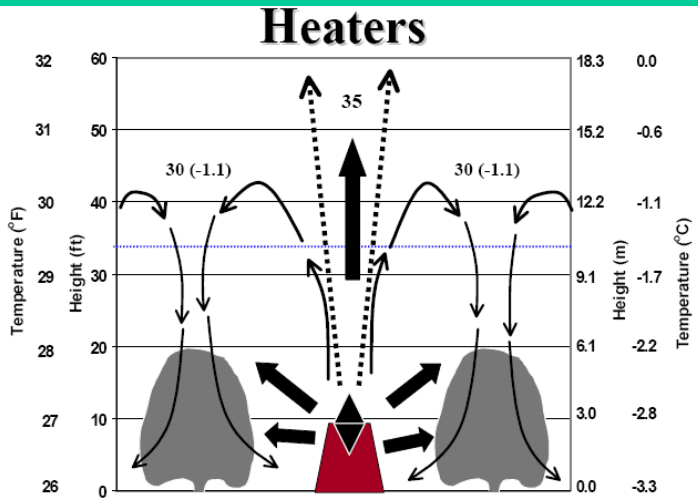
Upward long-wave radiation (W m-2) from furrow-irrigation water while it cools and freezes as it flows down a field during a radiation frost night. In the upper figure, the water cools more rapidly and ice forms closer to the inlet

Frost: Wind Machine



Effect of wind machines on temperature profiles during a radiation frost

Frost: Heater

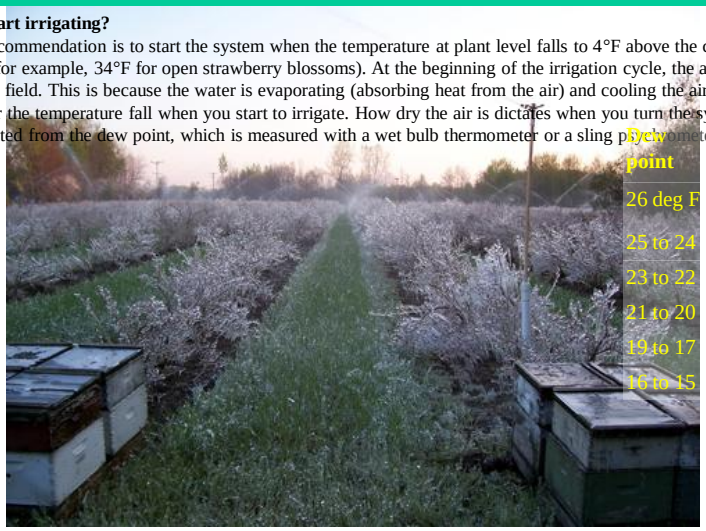


The energy effect of a smudge pot heater on temperature within an inversion

Frost: Sprinkle Irrigation

When can Start irrigating?

A common recommendation is to start the system when the temperature at plant level falls to 4°F above the critical temperature (for example, 34°F for open strawberry blossoms). At the beginning of the irrigation cycle, the air temperature will fall in the field. This is because the water is evaporating (absorbing heat from the air) and cooling the air. The dryer the air, the greater the temperature fall when you start to irrigate. How dry the air is dictates when you turn the system on. This can be calculated from the dew point, which is measured with a wet bulb thermometer or a sling psychrometer.



Dew point	Start irrigation at:
26 deg F	34 degrees F
25 to 24	35
23 to 22	36
21 to 20	37
19 to 17	38
16 to 15	39

When can I stop irrigating?

Generally, irrigate should be stopped after the sun comes up and begins to warm the ground. Stop irrigating when the ice is melting and temperatures are above freezing and rising. Ice breaking free from branches indicates water is forming under the ice and it is likely safe to quit. Beware of sudden dips in the temperature soon after sunrise

Frost: Use of Helicopters

During cold and still conditions, the down draught from the helicopter causes the slightly warmer air layered above to circulate amongst the crop fields, reducing the likelyhood of frost damage. Helicopters are effective for frost protection for up to 50 acres at a time

Frost: Foggers

Natural fog is known to provide protection against freezing, so artificial fogs have also been studied as possible methods against frost damage. Fog lines that use high-pressure lines and special nozzles to make small (i.e. 10 to 20 mm diameter) fog droplets have been reported to provide good protection under calm wind conditions. Protection comes mainly from the long-wave blocking effect and water droplets absorbing long-wave radiation from the surface and re-emitting downward long-wave radiation at the water droplet temperature, which is considerably higher than apparent clear sky temperature. The water droplets should have diameters about 8 mm to optimize the absorption of radiation and to prevent the water droplets from dropping to the ground. A fairly dense cloud of thick fog that completely covers the crop is necessary for protection

Frost: Crop Categorization

Crop	Temperature (°C) Harmful to plant in the phase		
	Germination	Flowering	Fruiting
Highest resistance to frost			
Spring wheat	(-9) - (-10)	(-1) - (-2)	(-2) - (-4)
Oats	(-8) - (-9)	(-1) - (-2)	(-2) - (-4)
Barley	(-7) - (-8)	(-1) - (-2)	(-2) - (-4)
Peas	(-7) - (-8)	(-2) - (-3)	(-2) - (-4)
Coriander	(-8) - (-10)	(-2) - (-3)	(-3) - (-4)
Resistance to frost			
Beans	(5-) - (-6)	(-2) - (-3)	(-3) - (-4)
Sunflower	(-5) - (-6)	(-2) - (-3)	(-2) - (-3)
White mustard	(-4) - (-6)	(-2) - (-3)	(-3) - (-4)
Sugar beets	(-6) - (-7)	(-2) - (-3)	---
Carrot	(-6) - (-7)	---	---
Turnip	(-6) - (-7)	---	---
Medium resistance to frost			
Cabbage	(-3) - (-7)	(-2) - (-3)	(-6) - (-9)
Soybeans	(-3) - (-4)	(-2) - (-3)	(-2) - (-3)

Frost: Crop Categorization

Crop	Temperature (°C) Harmful to plant in the phase		
	Germination	Flowering	Fruiting
Low resistance to frost			
Corn	(-2) - (-3)	(-1) - (-2)	(-2) - (-3)
Millets	(-2) - (-3)	(-1) - (-2)	(-2) - (-3)
Sorghum	(-2) - (-3)	(-1) - (-2)	(-2) - (-3)
Potatoes	(-2) - (-3)	(-1) - (-2)	(-1) - (-2)
Sudan grass	(-2) - (-3)	(-1) - (-2)	(-2) - (-3)
No resistance to frost			
Cotton	(-1) - (-1.5)	(-0.5) - (-1)	(-1) - (-2)
Castor Plant	(-1) - (-2)	(-1) - (-2)	(-0.5) - (-2)
Mellons	(-1) - (-2)	(-1) - (-2)	(-2) - (-3)
Rice	(-0.5) - (-1)	(-0.5) - (-1)	(-0.5) - (-1)
Peanuts	(-0.5) - (-1)	---	---
Cucumbers	(-0.5) - (-1)	---	---
Tomatoes	(-0) - (-1)	(-0) - (-1)	(-0) - (-1)
Tobacco	(-0) - (-1)	(-0) - (-1)	(-0) - (-1)

Flood

Webster's New Riverside University Dictionary of English Language defines flood as "an overflowing of water onto normally dry land", or "an abundant flow or outpouring; to become inundated or submerged".

The American Meteorological Society's Glossary of Meteorology (1970) defines a flood as "the condition that occurs when water overflows the natural or artificial confines of a stream or other body of water, or accumulates by drainage over low-lying areas".

Floods also have temporal characteristics; those that occur in a short period of time or come quickly are called flash floods and are defined by the glossary to be, "Floods that rise and fall quite rapidly with little or no advance warning, usually as the result of intense rainfall over a relatively small area. Other possible causes are ice jams, dam failure, etc.".

Flood: Effects

A) Non-growing season or fallow period:

1) Loss of topsoil
2) Loss of soil nutrients
3) Soil compaction
4) Soil erosion
5) Deposition of undesirable materials
6) Displacement of persons
7) Breakage of levees (an embankment built to prevent the overflow of a river) and other retention structures
8) Anaerobic processes
9) Permanent cessation of farming in floodplains
10) Permanent diversion/realignment of rivers, streams, other bodies of water and settlements.
11) Loss of livestock and/or habitat

Flood: Effects

B) Growing season:

1) Waterlogging of crops
2) Lodging of standing crops
3) Loss of soil nutrients
4) Loss of pasture use
5) Soil erosion
6) Greater susceptibility to diseases and insects
7) Interruptions to tillage, planting, crop management, harvesting
8) Permanent damage to perennial crops, trees, livestock, buildings and machinery
9) Soil temperature reduction and/or retardation
10) Loss of expensive drainage systems
11) Transportation interruptions
12) Grain spoilage, in-field and off-site
13) Feedback effect, enhancing precipitation due to large, free-water evaporative surfaces

Flood: Mitigation Strategies

A) Strategic Decisions

1) Reliable Flood Warning system
2) Flood control: Construction of dam, reservoir, canals etc, widening of rivers.
3) Introduction of water drainage systems
4) Introduction of water tolerant crops

B) Tactical Decisions

1) Draining out the water
2) Contingency crop planning
3) Increase percolation rate
4) More use of fertilizer to increase growth rate and ET losses
5) Sowing of crop on ridges

Cyclone, Hurricane, Storms

The intense low pressure (closed) systems developed over the oceans is called as Cyclone. Tropical cyclones are the off-spring of ocean-atmosphere interaction, powered by heat from the sea, driven by the easterly trades and temperate westerlies, the high planetary winds and their own fierce energy.

Tropical cyclones, hurricanes and typhoons are regional names for what is essentially the same phenomenon. Depressions in the tropics which develop into storms are called tropical cyclones in the south-west Indian Ocean, the Bay of Bengal and the Arabian Sea, parts of the south Pacific and along the northern coasts of Australia; these storms are called typhoons in the north-west Pacific and are known as hurricanes in the Caribbean, south-east United States and Central America. In the Philippines they are called bagious.

STORM SURGE: A storm surge is the abnormal rise of the sea level caused by the movement of the cyclonic storm over a continental shelf. It is caused by the pressure drop near the storm centre and the surface drag due to the strong winds accompanying the storm. Storm surge is the most devastating feature associated with a tropical cyclone. Most loss of human life and cattle is due to storm surges.

Cyclone: Agril Losses & Prevention

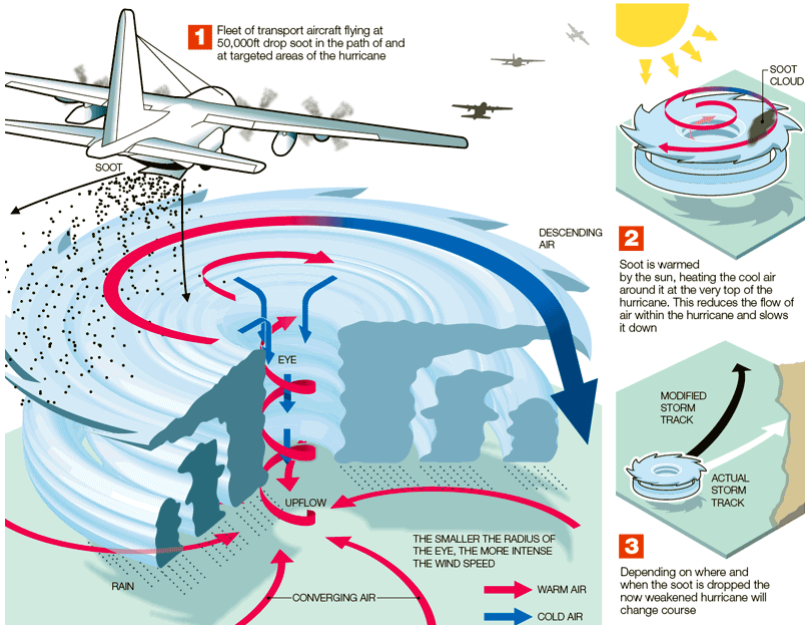
Destruction:

- Destruction of vegetation, crops, orchards and livestock
- Damage to irrigation facilities such as canals, wells and tanks; and
- Water logging due to storm surge.
- Long-term loss of soil fertility from saline deposits over land flooded by sea water.

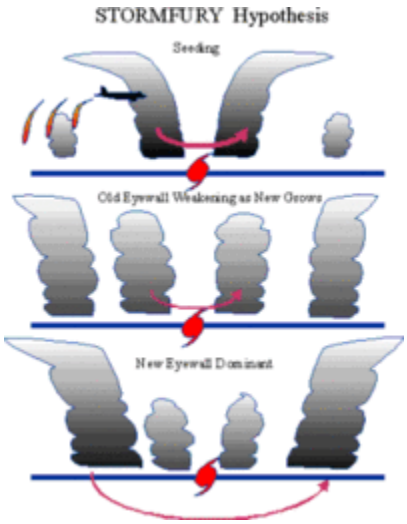
Prevention from Storm Surge: Coastal embankments susceptible to storm surges should be designed specifically to withstand the expected storm surge water heights and forces, the combined action of wind and waves and overtopping from the storm surge water. Pumping station and drainage channels should also be installed for pumping out the surged water.

Prevention from Cyclone: Installation of reliable cyclone warning system. Seeding or outer rain clouds to cause premature precipitation.

How to Halt a Hurricane



Cyclone: Mitigation



Hailstones

Hailstones: Hailstones are particles of dense ice falling from powerful cumulonimbus. The phenomenon usually occurs during the warm season. Hailstones are transparent or partially opaque particles of ice that range in size from that of sweet-pea seeds to baseballs; and is shape from spheres to rounded cones. The size of hailstones is considered between 5 to 50 mm.

Losses:

1) Physical plant injuries
2) Pest and disease attack after physical injuries
3) Lodging of crop when hailstones associated with high wind speed
4) Cold injuries
5) Hinderance in management operations
6) Disturbing physical properties of soil

Hailstones: Mitigation

Mitigation

The most effective regulation of hailstone growth is carried out by the injection of crystallizing reactants. To prevent the growth and fallout of hailstones it is necessary to detect the hail centre in a cloud at the right time (using a radio-locator) and then to inject crystallizing reactants. Logistically, it is necessary to ensure the capability of injecting reactants in any part of the region being protected. The injection of reactant into clouds is carried out in two ways: (i) bombarding clouds by artillery projectiles containing the crystallizing substance; (ii) using counter-hail rockets. Silver iodide and lead iodide are used as crystallizing reactants, which promote cloud growth rather than hailstone development. Effective anti-hail protection is dependent upon reliable, accurate forecasting.