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Essential of Sun Light in Crop Production

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Along with water and nutrients, solar radiation (sunlight) is an essential input for plant growth. Plant leaves absorb sunlight and use it as an energy source in the process of photosynthesis. A crop's ability to collect sunlight is proportional to its leaf surface area per unit of land area occupied, or its "leaf area index (LAI)". At "full canopy" development, a crop's LAI and ability to collect available sunlight are maximized. From full canopy through the reproductive period, any shortage of sunlight is potentially limiting to corn yield. When stresses such as low light limit photosynthesis during ear fill, corn plants remobilize stalk carbohydrates to the ear. This may result in stalk quality issues and lodging at harvest. The most sensitive periods of crop growth (*e.g.*, flowering and early grain fill) are often the most susceptible to stresses such as insufficient light, water or nutrients The importance of the solar radiation for the crop production process is understand especially on general level *i.e.* that solar energy is the driving force and only source of energy for photosynthesis (Penning de Vries *et al.*, 1989). The utilization of solar energy for photosynthetic activity is limited by low content of carbon dioxide in air especially during clear summer days, by unsuitable canopy structure (mutual shading of leaves) and by lack of water or (and) minerals. Solar radiation (SRAD) is one of the main factors influencing biomass and yield production and its quality *e.g.* high 1000-grain weight is beside other factors associated with prolonged SRAD in the phase of stem elongation and grain filling while low intensity of SRAD during grain filling phase negatively influences grain yield.

What is Solar Radiation?

Solar radiation is the set of electromagnetic radiation emitted by the Sun. The Sun behaves almost like a black body which emits energy according to Planck's law at a temperature of 6000 K. The solar radiation ranges go from infrared to ultraviolet. Not all the radiation reaches Earth's surface, because the ultraviolet wavelengths, that are the shorter wavelengths, are absorbed by gases in the atmosphere, primarily by ozone. Solar radiation is radiant (electromagnetic) energy from the sun. It provides light and heat for the Earth and energy for photosynthesis. This radiant energy is necessary for the metabolism of the environment and its inhabitants. The three relevant bands, or ranges, along the solar radiation spectrum are ultraviolet, visible (PAR), and infrared. Of the light that reaches Earth's surface, infrared radiation makes up 49.4%, while visible light provides 42.3%. Ultraviolet radiation makes up just over 8% of the total solar radiation. Each of these bands has a different impact on the environment. The atmosphere acts as a filter to the bands of solar spectrum, and at its different layers as solar radiation passes through it to the Earth's surface, so that only a fraction of it reaches the surface. The atmosphere absorbs part of the radiation reflects and scatters the rest some directly back to space, and some to the Earth, and then it is irradiated.

Types of Solar Radiation

The total solar radiation, often called as global radiation is the sum of direct, diffuse and reflected radiation. The solar radiation available to us is always a mix of the above mentioned three components. The actual percentage of each of these components varies as the different parameters, such as weather, location etc. change. In order to monitor and analyze the performance of solar plants, monitoring the global radiation is essential but depending upon the plant capacity and location, monitoring the composition of global radiation might also make sense.

Solar radiation on the earth can be classified as:

Direct radiation: This radiation comes directly from the sun without any change in its direction. This type of radiation is characterized by projecting defined shadow onto the objects that intersect. Direct radiation is received from sun rays travelling in a straight line from sun to the earth. Direction radiation is also termed as beam radiation or direct beam radiation. As direct radiation is sun rays travelling in a straight line, shadows of the objects which come in the way of sun rays are formed. Shadows indicate the presence of direct radiation. In sunny regions and during summers, direct radiation accounts for almost 70-80% of the total radiation present. In solar plants, solar tracking is implemented to absorb most of the direct radiation. If solar tracking system is not installed, valuable direct radiation would go un-captured.

Diffuse radiation: This radiation comes from all over the atmosphere as a result of reflection and scattering by clouds, particles in the atmosphere, dust, mountains, trees, buildings, the ground itself, and so on. Global radiation: Is the total radiation. It is the sum of the two radiations above. On a clear day with a clear sky, the direct radiation is predominant above the diffuse radiation. Direct radiation has a fixed direction. Diffuse radiation does not have any fixed direction. When sun rays are scattered by particles present in the atmosphere, these scattered sun rays account for the diffuse radiation. Shadows of the objects will not form if only diffuse and no direct radiation is present. As pollution increases, the amount of diffuse radiation also goes up. In hilly regions and during winters, the percentage of diffuse radiation goes up. Maximum amount of diffuse radiation is captured by the solar panels when they are kept horizontally. This means, in case of solar panels which are at an angle to track the most of the direct radiation, the amount of diffused radiation captured by the panels will go down. Larger the angle which solar panels make with the ground, lesser would be the quantity of diffuse radiation captured by the panels.

Reflected radiation: Reflected radiation is the component of radiation which is reflected from surfaces other than air particles. Radiation reflected from hills, trees, houses, water bodies accounts for reflected radiation. Reflected radiation generally accounts for a small percent in the global radiation but can contribute as much as 15% in snowy regions.

Basic Principles to Harvest

Solar energy provides light required for seed germination, leaf expansion, growth of stem and shoot, and flowering, fruiting and thermal conditions necessary for the physiological functions of the plant. Solar radiation plays an important role as regulator and controller of growth and development. Solar radiation also influences assimilation of nutrient and dry matter distribution. Some of the management practices are:

1. Optimum time of sowing
2. Optimum plant population
3. Timely application of fertilizers
4. Irrigation management etc. are aimed at increasing the interception of solar radiation by the foliage so as to get more yield.

Importance in Crop Production

The amount and intensity of solar radiation that a location or body of water receives depends on a variety of factors. These factors include latitude, season, time of day, cloud cover and altitude. Not all radiation emitted from the sun reaches Earth's surface. Much of it is absorbed, reflected or scattered in the atmosphere. At the surface, solar energy can be absorbed directly from the sun, called direct radiation, or from light that has been scattered as it enters the atmosphere, called indirect radiation. It has important impacts on plant growth and development. It will directly influence the plant physiological, biochemical and morphology such as photosynthesis, respiration and transpirational effects on water and nutrient uptake.

Effects of Radiation on Plants

1. Ultraviolet radiation affects plant growth and sprouting and the amount of damage is proportional to the radiation received. Due to radiation exposure soil can become compact and lose the nutrients needed for plants to grow.
2. Radiations disrupt the stomatal resistance. The stomata are a small air hole within the plant leaf that also controls water levels. If there is too much evaporation due to intense radiation the stomata close to reserve water. If the stomata are unable to open for a long period of time, the growth of the plant is stunted. Prolonged exposure to radiation can completely damage the stomata and ultimately the plant is destroyed.
3. Plant cells, contain chromosomes *i.e.*, the genetic material responsible for plant reproduction if the ceil is much damaged by radiation, then reproduction is hindered. As UV radiations destroy cells, the chances of mutation are increased. Affected plants are often small and weak with altered leaf patterns. 4. Prolonged radiation exposure can completely destroy the fertility of plant and the plant gradually dies.

Direct Effects

1. Chromosomal aberrations, defined as visually observable changes in chromosome structure.
2. DNA damage, defined as any damage to DNA molecules, including DNA sequence "inversion" (TCAG now GACT) as well as sections of sequences being "deleted".
3. Growth reduction, defined as a reduction in the rate of growth of organisms.
4. Reproduction effects, including sterility, reduction in reproduction rate, and occurrence of developmental abnormalities or reduction in viability of offspring.
5. Reduced seed germination.
6. Mortality, including both acute lethality and long-term reduction in life span.
7. Direct burn damage to exposed tissue.
8. The amount that a plant, or any organism, is affected by radiation is determined by how much radiation the organism receives, as well as long it is exposed.

Indirect Effects

Direct contact with radiation or radioactive materials is not required to affect local plant life; the mere presence of a reactor is often enough. To build a nuclear reactor, one requires a great deal of space, usually near water, which means clearing out any local vegetation. Heat given off by the reactor can change nearby water temperature, disturbing the delicate conditions required for coastal vegetation.

Factors Affecting Solar Radiation

There are 3 major factors are given below as:

1. Climatic factors:

a. Summer
b. Winter

c. Weather

2. Plant factors:

a. Plant species
b. Plant canopy
c. Leaf arrangement
d. Plant type

3. Edaphic factors:

a. Soil type
b. Soil cover
c. Soil color.

Conclusion

The utilization of incoming solar radiation is limited by other factors mainly by water availability either in form of rainfall, underground capillary inflow or irrigation. The effect of the increased solar radiation on maximum LAI values and total above ground biomass is more less the same as on grain yield and reaches the maximum close to the present values of incoming solar radiation even though it seems that slightly lower solar radiation intensity would have an positive effect in the sense of lower yield variability (without sacrificing much of the grain yield.

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