An investigation in to how Light intensity effects plant biodiversity.

Abstract

An investigation as to the effects of light intensity on plant biodiversity. My hypothesis stated that as light intensity increases, so does plant biodiversity. I investigated this through a practical case study of Hounslow Heath, using quadrats and a light meter to measure light intensity. The investigation proved my hypothesis to be correct.

Hypothesis

As light intensity increases, so does plant biodiversity

Variables:

- CO2 in atmosphere
- O2 in atmosphere
- Salinity of soil
- Soil moisture
- pH level of soil
- Nutrient content of soil
- Interspecific competition
- Temperature
- Humidity
- *Light intensity*

CO2

Carboxylation reactions occur in the light independent part of photosynthesis i n order to produce organic compounds. Carbon dioxide is therefore essential to a plant. Atmospheric air contains carbon dioxide at a partial pressure of approximately 0.04 kPa and it if for this reason that carbon dioxide is often a limiting factor. Howeve r a partial pressures of >1.0kPa, CO2 can potentially damage plants.

O2

O2 is required for plant respiration; it is a very similar reaction to that of photosynthesis, however respiration uses O2 and C6H12O6 to produce CO2 and H2O. There will always be adequate O2 around a healthy plant, as it will be producing it during photosynthesis.

Salinity of soil:

Osmosis is the key process in determining the speed at which a plants root system absorbs both water and dissolved nutrients. If soil salinity is high, the concentration gradient will mean water is likely to get drawn out of the plant, and any osmosis that occurs will be little and infrequent. This rate however may be dependent on the evolution of the specific plants and any adaptations it may have made w hilst being exposed to varying soil water salinities.

Soil Moisture:

Water is another essential component in a plants life. In order for cells to remain turgid and function efficiently they need a high level of hydration. Water is also a major source of electrons within a plant, for example in photosynthesis. A plants whole metabolism can be affected by dehydration.

pH level of soil:

The majority of plants are tolerant to a range of pH levels. Too high a pH can result in plant death. Issues such as acid rain are a great concern for plants as the amount of acid entering the soil is increasing. Some plants have adapted and are able to survive out of other plants pH range. Plants such as evergreens have slightly acidic needles, the dropping of these needles increases the soils pH levels and means lots of plants cannot live in the high pH soil now created.

Nutrient Content of Soil:

There are two types of nutrient required by plants; they are grouped according to the amount that the plant requires of each nutrient. The biggest group is the macronutrients; these are nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. The macronutrients are only needed in small amounts. These are iron, boron, copper, manganese, chlorine and zinc. Nutrients are essential for plant growth. A plant will grow at its optimum rate until they run out of a nutrient growth then becomes limited. Nutrient deficiency is often shown through discolouration or deformity.

Interspecific Competition:

This is competition between different species of plant. There is a limit to the availability of essential resources. When these resources are limited, competition increases. High competition will result in a lower growth rate and a decreased ability to reproduce. Competition also reduced population growing too much and acts as a natural form of environmental resistance.

Temperature:

In order for metabolic reactions to occur, a certain temperature must be maintained. Too cold a temperature however will often lead to plants freezing and dying, too high a temperature will lead to plants becoming easily dehydrated.

Background Information

Hounslow Heath

The heath in Hounslow overlies the Taplow river terrace, deposited by the great river Thames approximately 20,000 years ago. It has formed on a flat gravel drift. This drift means that the soil is slightly acidic and well drained; this is the basis of what makes 'Heathland'.

Heather is the predominant plant of the heath, though there are thousands of other species. Grasses include purple moor-grass, common-bent grass and crested dog's tail Herbs are also abundant. Something that makes the heath special is the fact that

despite its hectic history, including hunting and more recently stock car racing, Heather continues to reappear.

Light Intensity

As more photons of light fall on a specific area, light intensity is said to increase. The greater the number of photons falling on plant, the more ionised chlorophyll molecules and the greater the amount of ATP produced. Too much light is de trimental, as chlorophyll is damaged and the rate of photosynthesis is reduced.
Not all plant species react to certain light intensities the same way. Both shade tolerant and shade intolerant plants have adapted. Shade tolerant plants have the ability to photosynthesise in light of a particularly low intensity. This means that often they can grow in shady, dim places. Shade intolerant plants must be in a bright environment to survive, as they require a fairly high light intensity in order to support their growth and living.

Photosynthesis

Photosynthesis is series of reactions controlled by specific enzymes. It can be represented by the equation;

$$CO2 + H2O \xrightarrow{\text{(Light)}} \underset{\text{(Carbohydrate)}}{(CH2O)} + O2$$

This reaction allows us to see that photoautotrophs synthesise carbohydrates using water, CO2 and light energy. There are two parts to photosynthesis;
The light dependent reactions and the light independent reactions.
The light dependent reactions:
During these reactions chlorophyll traps energy from the light and uses that energy to make ATP molecules. This process is known as photophosphorylation. Alongside

photophosphorylation water molecules are split in to electrons, molecular oxygen and hydrogen ions. Nicotinamide adenine dinucleotide phosphate (NADP) a carrier molecule, react with the electrons from the water molecules. This reaction changes NADP from an oxidised state (NADP+) to a reduced state (NADPH). This process requires a great deal of energy, gained from light energy being trapped by chlorophyll.

The light-independent reactions;

In these reactions the ATP and NADPH produces are used to reduce CO2. A three-carbon compound, glyceraldehyde 3 -phosphate is produced.

Lights effect on chlorophyll

When light is at the wavelength absorbed by chlorophyll, the rate of photosynthesis is at its optimum. Light absorbed by a chlorophyll molecule is directly absor bed by electrons. These electrons 'excited' and move to an energy level known as photoexcitation. When electrons have absorbed enough energy, they leave their chlorophyll molecule, positively charged, and move out. This process is photoionisation. Within whole chloroplasts each chlorophyll molecule has both an electron acceptor and an electron donor, all three components make up a photosystem. When photoionisation occurs, the acceptor takes up the energised electrons, and the electron donor, donates a pair of electrons, thus making the chlorophyll molecule stable once more.

The electrons now within the electron acceptor are carried through an electron transfer system, back and forth, through the thylakoid membrane. It is this process here that generates sufficient energy for ATP to be synthesised from ADP and a phosphate.