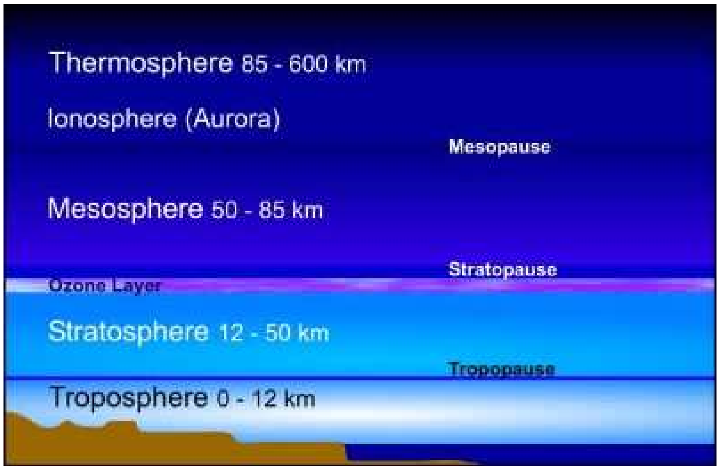
An Investigation into How Ultraviolet Radiation Effects the Growth of Crop Seeds

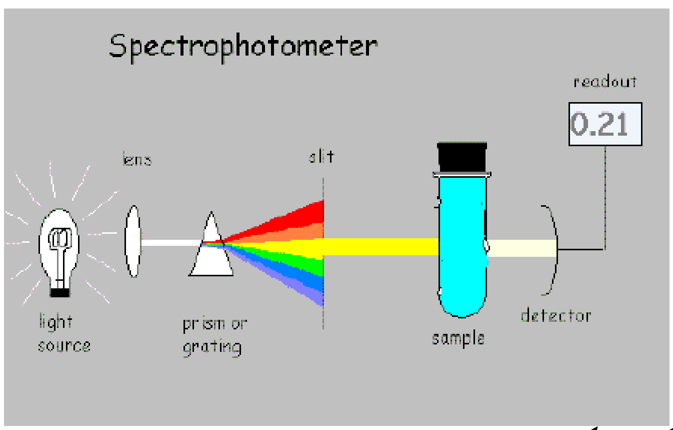
Introduction

The ozone layer, also known as the ozonosphere, is found in the Earth's stratosphere.



Above is a diagram explaining where the ozone layer is situated in the atmosphere

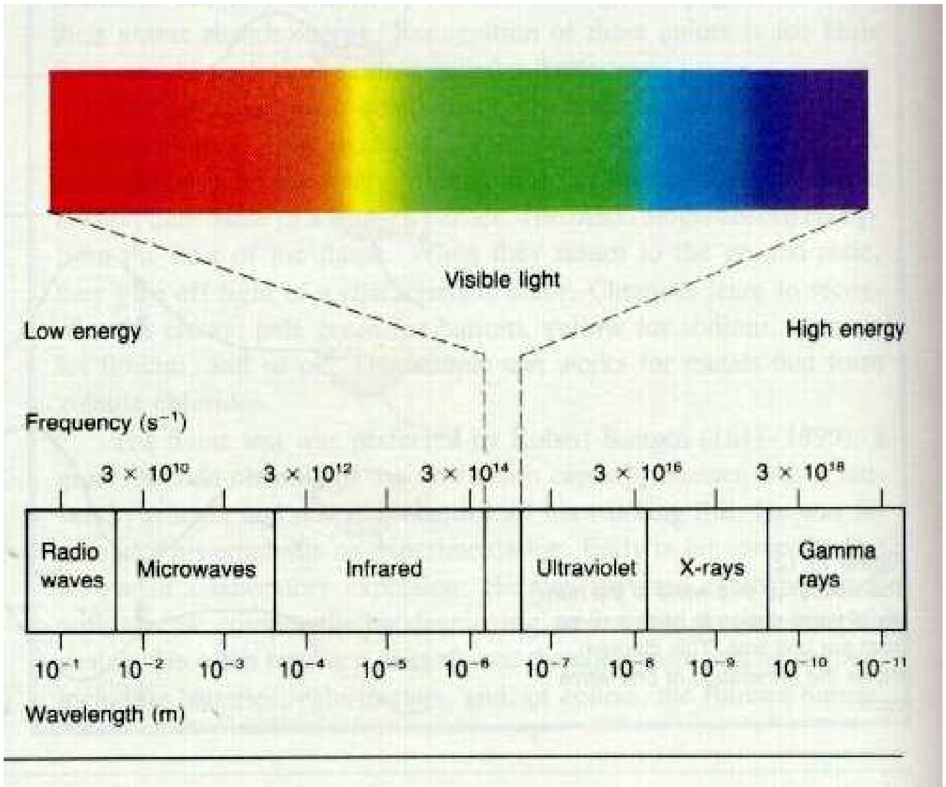
Over 90% of the Earths ozone can be found here. That doesn't mean to say that ozone is only found in the atmosphere. It can be easily produced by any high voltage arc here on earth for example a spark plug and a Van de Graaff generator.
The ozone layer was discovered by two French physicists, Charles Farby and Henri Buisson, in 1913. But it was a British meteorologist, G.M.B Dobson who explored its properties by using a spectrophotometer.



Above is a diagram of the basic working of a spectrophotometer

This instrument was used to measure stratospheric ozone from the ground.
Between 1928 and 1958 a worldwide network of ozone monitoring stations was established by Dobson. They still continue to operate today.
It was in 1985 that British scientists at the British Antarctic Survey discovered that a hole had appeared during the southern spring in the layer above Antarctica. This was completely unexpected so scientists began to research why the hole had appeared and what it was that had caused it to appear.
Because the chemistry of the ozone layer is so dynamic and complex it took scientists many years to work out that it was the fault of chlorine atoms introduced into the atmosphere by human activities. After this discovery international action was taken in the form of the Montreal Protocol. It was amended in 1990 and 1992.
The Montreal Protocol insists that "the production and consumption of compounds that deplete ozone in the stratosphere, CFC's, halons, carbon tetrachloride and methyl chloride, are to be phased out by 2000".

The hole above the ozone layer is unstable as its size keeps shrinking and growing. This means that it hasn't closed up and is still letting in harmful ultraviolet (UV) radiation from the sun.



Above is a diagram of the light spectrum showing where Ultra violet radiation is situated.

These UV rays can affect the body in a simple way in the form of sun burn. Constant exposure to UV light can lead to mutation of DNA within the skin and therefore skin cancer.

Harm to the human body is an obvious side effect of over exposure to the sun and therefore UV radiation however we are not the only organism on the planet that is affected by these harmful rays. Plants and many organisms are also affected.

UVA radiation is responsible for pigmentation of the skin in the form of a sun tan. It can be found between 350nm – 315nm.

UVB radiation, which can be found in the middle of the UV region of the light spectrum between 315nm – 280nm, can cause skin cancer and has also been linked to damage to crops and marine organisms.

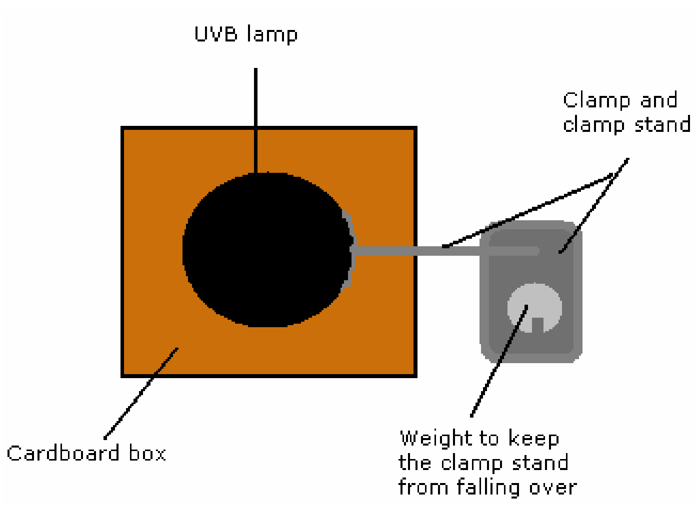
UVB enhancements on plants include reduction in yield and quality, alteration of species competition, a decrease in photosynthetic activity, susceptibility to disease and changes in the plant structure, such as a decrease in plant height and leaf area. It also affects plant pigmentation and dry matter production in crops.

Agricultural scientists have responded to these findings with a series of ground-breaking investigations on the effect of artificial and solar UV radiation upon plant growth and development. However most of these experiments have involved the use of UV lamps which usually emit radiation quite unlike the radiation present in the normal terrestrial solar spectrum.

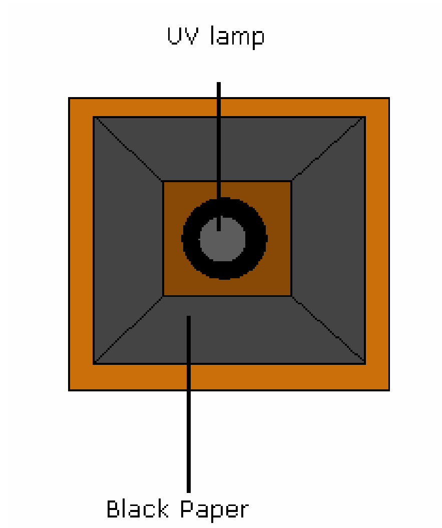
After conducting research on the internet I came across an experiment carried out by the United States Department of Agriculture, UVB Monitoring and Researching Program. In this experiment they sampled 16 rice cultivars from several different geographical regions. Each variety of rice was grown in greenhouses which had supplemental levels of

UVB radiation. Alterations in biomass, morphology and maximum photosynthesis were determined.
One third of all varieties that were tested showed a statistically significant decrease in total biomass as the UVB radiation was increased.
For these responsive varieties the leaf area and the tiller number were also significantly reduced.
In some varieties the photosynthetic capacity, as determined by the oxygen evolution, had also declined.

In this investigation I shall be exploring how crop seeds are affected by UV radiation.
I am going to subject two different crop seeds, radish and broad bean, to 20 minute sessions of UV radiation once a week. I have chosen to grow radishes and broad beans because they are easy to get hold of at this time of the year. Radishes grow very quickly, ready to harvest 25-28 days after sowing the seeds however broad beans are very slow to grow and are ready to harvest up to 70 days after sowing. Each week before I turn on the UV lamp I shall record the growth rate of each plant and any mutations that appear, such as decrease in leaf area, abundance of fruit (when present) and height of each plant. I am also going to grow a separate batch of radish and bean seeds. These however will not be subjected to radiation of any sort. This second batch will be left alone to grow as naturally as possible. This will be my controlled experiment. As with my radiated plants I shall measure each plant weekly. I will also measure the leaf area, abundance of fruit and the height of each plant.
In order to protect the controlled seeds from being contaminated by the UV lamp and also to protect myself from any harmful rays I shall be growing the radiated seeds inside a cardboard box. The inside of the box will be covered in black paper. This will prevent any natural UV in the form of sunlight from reaching the plants as they grow. In the top of the box I will cut a hole which I will place the UV lamp through. This will enable me to turn the UV lamp on and off without exposing myself to the potentially dangerous rays given off. As soon as each plant produces leaves it will need light to photosynthesise, I will place a free standing bulb next to each set of plants to ensure that each plant is receiving the necessary light allowing it to grow as naturally as possible. Each plant will be stood on 24cm X 24cm filter paper, this will allow the plant to take up water as and when it needs it.



Above is a very rough diagram of how I expect the top of the box to look



Above is a very rough diagram of how I expect the inside of the box to look

Above is a picture showing the UVB lamp I am going to use in my experiment

Hypothesis

I hypothesize that after prolonged exposure to the UVB radiation both sets of crop plants will be affected in the following ways; each plant will show a decrease in growth rate, height and leaf area. However I believe that only one plant will show a decrease in yield of crop.

Radish Plant

I believe that due to radishes being root vegetables the yield of crop from each plant will not be affected by the UVB radiation as they are not directly exposed to the potentially harmful rays. However I think that the height and growth rate of the plant as well as the leaf area will show an overall decrease due to them growing on the top of the soil and in direct exposure of the UVB lamp.

Broad Bean Plant

I think that compared to the radish plants the broad bean plants will be directly affected by the UVB radiation as they are not root vegetables and produce their fruit proud of the soil. I would imagine that the yield of crop and growth rate, height and leaf area of the plant will show an overall decrease.