Experiment to investigate the effect of moisture content on wheat grain seeds respiration rate

AIM: The aim of this experiment is to find out the effect of moisture content on a wheat grain seed's respiration rate.

HYPOTHESIS: There will be a positive correlation between moisture content of wheat grains and their respiration rate. Therefore as the moisture content (independent variable) increases so will the respiration rate (dependent variable).

The rationale behind the hypothesis came from studying photosynthesis in plants. During the light-dependent reactions of photosynthesis, the photolysis of water (H_2O) occurs inside photosystem II. The products of photolysis combine with NADP from photosystem I, to form reduced NADP. This reduced NADP passes to the light-independent reactions of photosynthesis, where it is utilised to make triose phosphate from glycerate 3 phosphate. Without water, photolysis would not occur and therefore the light-dependent and light-independent reactions would not take place at all. Therefore I would predict that the higher moisture content of wheat grain seeds the higher the respiration rate will be, this is because the seeds will be able to utilise more water than a wheat grain seed with low moisture content.

VARIABLES: The independent variable used in this experiment is going to be moisture content, and the dependent variable will be the respiration rate. The other variables; temperature, air pressure and air will be kept at fairly constant levels. Carrying out the experiment inside a fume cupboard will help achieve in keeping these variables to remain constant. However another variable sunlight cannot be controlled during this experiment, and will obviously vary during the experiment. The possibility of using a standard light bulb to keep light levels constant was considered, but was rejected due to safety fears e.g. overheating when the experiment was not being monitored during the time between readings.

BACKGROUNG KNOWLEDGE: Deterioration of stored grain seeds is an important economic problem in agriculture, therefore it is important to find out the most suitable conditions for stored grain seeds to be maintained in. For this experiment wheat grain has been chosen, this is because it is widely cultivated around the world e.g. the Mediterranean and West Asia, and is used to make flour and pasta. This means wheat is a staple crop throughout the world, and its storage is essential.

To store grain effectively it is important to stop germination from occurring at all. Germination is the onset of growth of the embryo in a seed, this usually happens after a period of dormancy. Dormancy is the state where germination will not occur, even if environmental conditions are favourable. This is often an advantage for seeds, as it allows germination to occur in a more favourable season. In the case of wheat seeds they need several weeks or months of

prechilling before the will actually germinate. Prechilling is the exposure to low temperatures in moist conditions with oxygen (o) for weeks or months.

For germination to occur it is established that water, oxygen and a suitable temperature are required. Germination is initiated by the uptake of water (imbibition). Water has several vital functions; it is an essential solvent, which allows biochemical reactions to occur in solution, and transports nutrients to the embryo from the food reserves. Water is also a reagent, taking part in the many hydrolysis (digestive) reactions, which allow the endosperm to be broken down.

If the stored grain seeds come in contact with water and are in other suitable conditions that germination requires, the seeds will germinate. As the seeds grow the radicle and plumule emerge due to the metabolic reactions carried out by the seeds enzymes, such as the respiration process, the seedlings are then likely to spoil and die. This is caused by the conditions the stored grains are kept in, the dead seedlings provide the right environment for fungal and bacterial spores to live and reproduce. These spores then will start to destroy other seeds close to it, as well as producing moisture to surrounding seeds, which will cause them to germinate as well. These in turn will die and provide ideal conditions for more fungal and bacterial spores to develop, thus causing a de structive cycle. This cycle will ruin the stored grain, which is in storage.

Deterioration of stored grain is an economic problem for More Economically Developed Countries (MEDCs) and Less Economically Developed Countries (LEDCs). In both it will cause agriculture to lose profits, as well as loss in food for their animals. However it is a more serious problem for LEDCs because often they only produce one type of crop, which the surrounding villages rely on for their food. If the wheat seeds are spoilt, it may cause starvation of the villagers, even a famine if spoilage is a countrywide problem. Starvation will cause protein energy malnutrition such as kwashiorkor and marasmus. Starvation can also cause oedema, wasting and stunting, as well as death. This obviously causes huge economic problems for such countries. Therefore the proper storage of grain is important in maintaining a countries economic system.

APPARATUS:

20 Wheat grain seeds
Respirometer:
- **10cm3 (x25) Oxygen absorbing Solution (to be deter mined)**
- **2 Test Tubes**
- **2 Test Tubes Bungs**
- **Glass Beads**
- **1 cm3 Syringe**
- **Screw Clip**
- **2 Gauze Platforms**
- **20 Glass Beads**

Manometer
Digital Weighing Scales
Stop Watch
50cm3 Distilled Water (x25)
2 1cm3 syringe

In this experiment a digital weighing scales has been chosen to measure the moisture content of the wheat grain seeds. This can be done by weighing the mass of the seed before it comes in contact with water, and then weighing them again after exposure to water. The mass of the seed before exposure can then be subtracted from the mass after exposure, which will then give the total moisture content of the seed. As the experiment progresses water content should increase as the seeds have had more time to absorb the water molecules.
To measure the respiration rate we are going to use a respirometer. The respirometer measures the rate of $C0_2$ produced by the seeds. The oxygen produced in respiration is absorbed by a suitable chemical, in the bottom of the test tubes. Any decrease in the volume of air surrounding the seeds results from their CO_2 consumption. CO_2 consumption in unit time can be measured by reading the level of the manometer fluid against the scale. Changes in air pressure and temperature can affect the apparatus, therefore to keep the surroundings constant the experiment will take place in a fume cupboard. The presence of a control tube containing an equal volume of inert material to the volume of organisms used helps to compensate for changes in atmospheric pressure. The respirometer was chosen to measure respiration rate, because it is the most effective piece of equipment with the highest accuracy available for the experiment at college. It is also a relatively easy apparatus to set up and readings are easily made, however reading may vary from person to person. This is because respiration rate is measured on the manometer, and it's reading could be easily misjudged.

All the apparatus that has been chosen for the experiment are safe, however as with any experiment due care has to take place, especially with glass as it can easily be broken and then it is dangerous.
Care must be taken when recording results so that they are accurate and reliable.

METHOD:

(1) Weigh the twenty seeds, and record the result.

(2) Set up the respirometer as follow: Add 10cm3 of the oxygen absorbing substance into each test tube using a 1cm3 syringe. Then place the gauze platform just above the solution in each tube. Add twenty seeds to the one tube this will be the experimental tube, and twenty glass beads to the other this will be the control tube. Then add 50cm3 of distilled water to each tube using a 1cm3 syringe.

(3) Attach both the tubes to the bungs on the respirometer. Making sure they are secure and air tight to the surroundings. Record the readings of the manometer for the control and experimental test tubes.

(4) After 2 hours, record the reading of the manometer on the respirometer.

(5) Remove the experimental and control tubes from the respirometer. Take out the seeds from the experimental tube, and wipe any moisture from their surfaces. Then reweigh the mass of the seeds and record the result.

(6) Remove both remaining solutions and glass gauze from the experimental tube and make sure the tube is cleaned.

(7) Add 10cm3 of oxygen abso rbing solution using a 1cm3 to the experimental tube, then add the glass gauze just above the solution once more. Then replace the twenty ORIGINAL seeds into the experimental tube along with 50cm3 of distilled water.

(8) Then repeat stages 3-7 every two hours, making sure that the readings are taken at the two-hour mark each time. Continue recording the results for a two day period (48 Hours), this should give a total of 25 different results for the manometer and a further 25 results for mass of the seeds (this includes the results taken at the start of the experiment when the seeds have no moisture content!).