PLANNING:-

Topic:
The effects of oil on plants.

Aim:
My aim is to compare the effect of heavy and light oil on terrestrial plants.

Hypothesis:
I hypothesize that light oils affect the plant life more quickly than heavy oils.

Biological Knowledge:
Most people in developed countries of the world use oil or oil products such as petrol and diesel. Oil is a common and highly visible form of water pollution when burned, but oil can also damage the environment when it is spilled at sea because of the way it spreads. Even a small quantity can cause a lot of harm to the aquatic environment.
Numerous factors determine the extent of damage to be expected from any spill. These include:

- Type of oil spilled
- The dose or amount of oil spilled
- The physical features of the region of the spill
- The biota of the region
- The season of year
- The previous exposure of the region to oil spills
- The present exposure of the region to other pollutants
- The treatment that was given to the spill

Huge oil tankers transport millions of gallons of oil, and if the ship hits a rock the oil spills out into the sea. Oil pollution is harmful in many ways. The most common types of oil pollutants are diesel, central heating oil, waste oil and petrol. Petroleum products released into the environment have an enormous impact on everything from plants to animals to people.

We can divide the hydrocarbons found in oil into 3 major classes of compound:

- Alkanes
- Cycloalkanes

- Arenas

There are two different types of oils classified into “Light oils” and “Heavy oils”.

LIGHT OILS: -

Light oils include crude oils. Crude oil or petroleum is thick, dark, and are smelly liquids; they are volatile (easily evaporated) so they usually don't remain for long in the environment typically no longer than a few days, and when their components have evaporated, a sticky tar called pitch is formed. If they spread out on the water, as they do when they are accidentally spilled, they will evaporate relatively quickly. However, while they are present, they present two significant hazards. First, some can ignite or explode.

Crude oil is a mixture, and because of this its composition varies.

Crude oil is composed mainly of hydrocarbons and there can be several hundreds of these because of carbon’s ability to form stable chains, branched chains and rings.

When crude oil is separated, there are 5 major fractions, which include:

-Refining gas
-Gasoline/ Naphtha
-Kerosene
-Diesel oil
-Residue

Other light oils such as fuel oils, which include gasoline and diesel fuel, are also considered to be toxic. They can kill animals or plants that they touch, and they are also dangerous to humans who breathe their fumes or get them on their skin.

HEAVY OILS: -

In contrast, very "heavy" oils (like bunker oils, which are used to fuel ships) look black and sticky and evaporate slowly. If this kind of oil washes ashore, it makes a big mess that can last for a long time (weeks, months, or even years). While these oils can be very persistent, they are generally significantly less acutely toxic than light oils. Instead, the threat from heavy oils comes from their ability to smother organisms. Also, if heavy oils get onto the feathers of birds, the birds may die of hypothermia (they lose the ability to keep themselves warm). We observe the same effect if sea otters become oiled. After days or weeks, some heavy oils will harden, becoming very like an asphalt road surface. In this hardened state, heavy oils will probably not harm animals or plants that come in contact with them.

In between light and heavy oils are many other oils, which would be "medium oils" that will last for some amount of time in the environment, and will have different degrees of toxicity.

EFFECTS ON PLANTS:-

Plants absorb water and nutrients from the soil, and light from the sun to grow. All nutrients will be carried into the plants roots, leaves, and stem by water. Water can also carry harmful material into the plant. Good nutrients can help plants grow faster; however, harmful material can have a reverse effect and slow down the plant growth. Knowing what material can help plant growth and what material are harmful for plants can help us protect our plants and produce healthier plants.

Kelp, marsh grass, mangroves, and sea grasses are some of the types of marine vegetation that are hurt by oil spills. Plants occupying the area between high and low tidemarks also feel the effects from spilled oil as they may be directly coated by oil stranded by a receding tide. Fortunately, these residents of watery habitats usually are able to recover once the oil has been removed or has degraded. These plant communities play a vital role in the habitat, and loss of plant cover can have a significant impact on other organisms in the ecosystem.

Marsh vegetation shows greater sensitivity to fresh light crude or light refined products whilst weathered oils cause relatively little damage. Oiling of the lower portion of plants and their root systems can be lethal whereas even a severe coating on leaves may be of little consequence especially if it occurs outside the growing season. In tropical regions, mangrove forests are widely distributed and replace salt marshes on sheltered coasts and in estuaries. Mangrove trees have complex breathing roots above the surface of the organically rich and oxygen-depleted mud in which they live. Oil may block the openings of the air breathing roots of mangroves or interfere with the trees' salt balance, causing leaves to drop and the trees to die. The root systems can be damaged by fresh oil entering nearby animal burrows and the effect may persist for some time inhibiting decolonisation by mangrove seedlings. Protection of wetlands, by responding to an oil spill at sea, should be a high priority since physical removal of oil from a marsh or from within a mangrove forest is extremely difficult.

OUTLINE METHOD :-

Factors: -

The variables include :-

- Heavy and light oil that plants will be receiving
- Soil
- Water
- Temperature
- Light
- My dependent variables are the measure of height of the plants that have been changed or affected by the oil.

Variables Controlled:-

- I sprayed the same amount of heavy and light oils every time.
- I planted all the beans in the same soil.
- I gave all of them the same amount of water-200 ml.
- They were all kept in the same place and so naturally got the same amount of light and had the same temperature.
- I measured the heights of the plants every alternate day.

Risk Assessments: -

I will make sure that: -

- I will wear a coat while carrying out the experiment.
- I will wear gloves while putting the soil and oiling the plants.
- I will wash my hand after putting the soil and after oiling the plants.
- I will be pouring the oil very carefully and not spilling it anywhere.
- I will place the pots in the Biology Lab in a safe place where they are not kept next to any switches where they might catch fire while I am pouring the oil and water.

Precautions: -

I will make sure that I: -

- Put holes in the 3 pots so that the extra water is drained out.
- Put the right amount of soil and see that all the seeds are embedded in them.
- Put equal amount of oil in all the 3 pots.
- Check their heights before oiling them.
- Place the plants where they get direct sunlight.

Ethics and laws: -

My investigation does not involve any experiment carried out on animals, or human life so it won't be an ethical problem. However, as I will use plants to carry out my investigation, I will make sure that I will not remove any plant from its natural environment and I will grow them on my own.
As my investigation will deal with oiling the plants I will make sure that I am very careful while carrying out the whole experiment.

Apparatus used: -

- 3 plastic pots with holes
- 20 kidney bean seeds
- Soil
- Heavy oil (Bunker)
- Light oil (Diesel)

Method

I will investigate the effect of heavy and light oil on kidney bean plants. I will wear an apron and gloves while planting them. I will plant 20 bean seeds even though I need only 15. I will plant 5 in each pot, having one control and two test plant pots. I will label the 1st pot as T1 (for light oil) and label the plants when they grow as L1, L2, L3, L4, and L5. I will label the 2nd pot as T2 (for heavy oil) and I will label the plants in them as H1, H2, H3, H4, and H5. I will then label the final pot as T3 (control) and label the plants in them as C1, C2, C3, C4, and C5.
I will make a hole in each of the 3 pots so that the excess water and oil could be drained out. I will put the same amount of soil in all of the six pots and I will allow them to grow near the window of my Biology Lab where they will get direct sunlight, and are open to the atmosphere and I will make sure that they are kept at a place where the oil wont catch fire while I am pouring it.
During the first week I will water them every alternate day but from week 2, I will water them everyday. I will let the plants grow for four weeks and then measure their heights and record them in a table.
Then I will collect the 2 different types of oils, which are the heavy bunker oil and the light diesel oil, and carefully pour them on the plants that I am growing. I will make a final table of the height and record the different readings of the control, and the plants with the light and heavy oil.
I will then get the average readings and check the differences in the readings and finally I will draw a graph with the percentage change.

Table for the height (cm) of the plants that are growing in T1: -

	L1	L2	L3	L4	L5
Week 4					
Day 2					
Day 4					
Day 6					
Day 8					
Day 10					
Average:					

Table shows the heights (cm) of the plants that are growing in T2: -

	H1	H2	H3	H4	H5
Week 4					
Day 2					
Day 4					
Day 6					
Day 8					
Day 10					
Average:					

Table for the heights (cm) of the plants that are growing in T3: -

	C1	C2	C3	C4	C5
Week 4					
Day 2					
Day 4					
Day 6					
Day 8					
Day 10					
Average:					

Predicted Result:

I predict that the plants that are growing in T1 (light oil) will die faster then the plants in T2. The reason for this is because light oils are very volatile so they won't stay in the soil for a long time. As they evaporate fast, the plants won't absorb anything so as a result of this it will affect the shoot system.

IMPLEMENTATION:-

Apparatus used:

- 3 plastic pots labelled with holes
- 20 kidney bean seeds
- Same type of soil
- Bunker oil-Heavy
- Diesel oil-Light
- Water
- Measuring tape

Method:-

I started my experiment by taking 3 pots and labelling the 1st one as T1 (for light oil), and then labelling the 5 plants in it as L1, L2, L3, L4, and L5. The 2nd pot was labelled as T2 (heavy oil) and the plants in them were labelled as H1, H2, H3, H4, and H5. The 3rd pot was the control and I labelled it as T3 (control) and the plants there were labelled as C1, C2, C3, C4, and C5.
I made small holes in the pots so that the extra water and the oil were drained out.
I then wore gloves and an apron and carefully put equal amount of soil in the pots so that it doesn't fall down. I then soaked the seeds in the soil and I placed them near the window of my biology lab where they get direct sunlight and where they wouldn't catch fire and were away from the main switches.
I then started watering them for 4 weeks regularly and finally at the end of the 4th week I measured the different plants with a measuring tape as they were not straight and wrote their results in a table.
Then 4 weeks after growing the plants when they were ready for the experiment, I collected the 2 different types of oil and sprayed the light oil (diesel) in T1 and the heavy oil (bunker) in T2. I continued watering the plants in T3 (control). I sprayed the oil on the plants very carefully making sure that no oil was spilt. I oiled them everyday and after every 2 days I recorded their measurements in a table. After 10 days I got down all the reading that I needed and plotted a graph and checked the differences in the readings before and after oiling the plants.

Observations:-

4 weeks after growing the plants: -

The plants in all the 3 pots grew normally and looked healthy. Leaves were dark green in colour. Some of the plants had large leaves with thick stems while some other plants had small leaves with thin stems. As the plants had grown very tall by now, I had to support them with twigs so that they don't bend and fall.

- Plants in T1 (light oils):

They all grew at a fast rate till Day 4 and the maximum height reached was 23.5cm and then by Day 5 there was a sudden fall and by Day 6 all the plants were dead.

- Plants in T2 (heavy oils):

They all grew at a very slow rate till Day 6 and the maximum height was 26cm. By Day 8 all the plants were dead. All the plants leaves had changed their colour to yellow and they were all dry and wilted.

- Plants in T3 (control):

They all grew normally with green leaves and there height kept on increasing till the last day of the experiment and the maximum height reached by the plants was 24 cm.

The final table showed readings, which includes: -

- Day 0: 4 weeks after growing the plants and when they were ready for the experiment (Before oiling them).
- Day 2: 2 days after I started oiling them.
- Day 4: 4 days after oiling them and so on till Day 10.

X indicates that the plants were dead.

- The readings are shown in the table below: -

The table below shows the height (cm) of the plants that were growing in T1 (light oil):-

Light oil (cm)	L1	L2	L3	L4	L5
Day 0	21	22	19	15	18
Day 2	22	23	21.3	16	18.2
Day 4	X	23.5	22.5	X	X
Day 6	X	X	X	X	X
Day 8	X	X	X	X	X
Day 10	X	X	X	X	X
Average (cm)	21.5	22.8	21	15.5	18.1

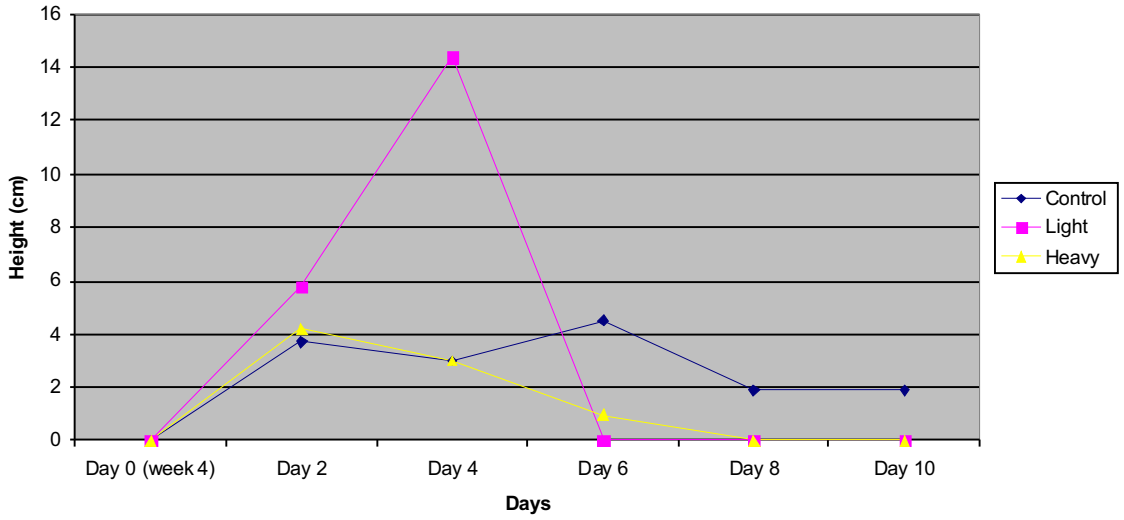
The table below shows the height (cm) of the plants that were growing in T2 (heavy oil):-

Heavy oil (cm)	H1	H2	H3	H4	H5
Day 0	19	22	15	16	24
Day 2	20.1	23.2	16	16.2	24.7
Day 4	21.7	23.2	16.7	16.5	25
Day 6	X	X	18	17	26.1
Day 8	X	X	X	X	X
Day 10	X	X	X	X	X
Average(cm)	20.2	22.8	16.4	16.4	18.95

The table below shows the height (cm) of the plants that were growing in T3 (control):-

Control (cm)	C1	C2	C3	C4	C5
Day 0	18	22	21	19	14
Day 2	18.5	22.2	21.5	20	15
Day 4	19.2	22.7	22	20.4	16
Day 6	20	23.5	23	21	16.7
Day 8	20	23.7	23.2	21.3	17
Day 10	20.5	24	24	21.7	17.5
Average (cm)	19.4	23	22.7	20.8	16.3

Graph showing percentage change in height.



ANALYSIS: -

The table below shows the average height of the plants growing in T1 (light oil), T2 (heavy oil) and T3 (Control).

Average height (cm)	T1	T2	T3
Day 0	19	19.2	18.8
Day 2	20.1	20	19.5
Day 4	23	20.6	20.1
Day 6	X	20.4	21
Day 8	X	X	21.4
Day 10	X	X	21.8

The table below shows the percentage change between the plants in T1, T2, and T3.

Percentage change %	T1	T2	T3
Day 0	0	0	0
Day 2	5.8	4.2	3.7
Day 4	14.4	3	3
Day 6	X	0.97	4.5
Day 8	X	X	1.9

Day 10	X	X	1.9

Trends for the plants in T1, T2 and T3:-

Day 0 (4 weeks after growing the plants): -

All the plants in the 3 different pots grew normally and looked healthy with green leaves.

Day 2: -

All the leaves in T1 and T2 grew at almost the same rate. There wasn't much change in the leaf colour.

Day 4: -

- The plants of T1 (light oil) had grown at a fast rate and their leaf colour had now started changing to yellow.

The plants in T2 (heavy oil) grew only a bit (not as long as the plants in T1). Their colour had changed to pale green.

- The plants in T3 (control) were still growing at a constant rate. Their leaves were still green and they looked healthy.

Day 6: -

- The plants in T1 had all died.
- The plants in T2, their heights had increased very little and the colour of the leaves started becoming yellow and they looked dry.
- The plants in T3 were constantly increasing and all the leaves were still alive.

Day 8: -

- The plants in T2 had all died also.
- The plants in T3 were all still continuing to grow but at a slower rate then before.

Day 10: -

- The plants in T1 and T2 were all dead.
- The plants in T3 were still growing at a slower rate. The leaf colours were now much lighter then how they previously were but none of the plants died.

Trends and patterns in the Percentage change Graph:-

From the curves of the graph, I can see that for the light oils, the height of the plants increased at a very fast rate till Day 4 and after that there was a sudden drop and the plants stopped growing and by Day 6 almost all the plants were dead.

As for the plants with heavy oil, their heights increased but not with that fast rate as it were for the heavy oil. The heights increased till Day 6 and after that there was a drop and by Day 8 almost all the plants were dead.

The curves for the control show that their heights continuously increased till Day 4 and after that their height was increasing but at a slower rate till Day 6.After that till Day 10 the plants were all still growing and none of them were dead but they were growing at a much slower rate.

Scientific Explanation for my result:-

According to my results I can see that the light oils affected the plants more quickly. The reason for this is because light oils are more toxic and very volatile so it evaporates very quickly. As it evaporates, it won't remain in the soil for a long time so it mostly affects the root system of the plants, as the roots won't have any material to absorb. As a result of this when the root system is affected the plants gradually die fast.

Whereas the plants in which the heavy oils were poured, were affected at a much slower rate. This is because when heavy oil is poured on the soil, it evaporates at a very slow rate, as it is non-volatile. As the heavy oils are less dense then water, it forms a thin layer on the surface of the soil. It is less toxic than the light oils so as a result this affects the shoot system. Because

of this photosynthesis doesn't occur and so as a result of this, the leaves of the plants changes its colour from green to yellow and that is why the plants take a longer time to die.

Conclusion:-
From all the results I got, I conclude that overall the light oils affect the plants much quickly then the heavy oils because they are volatile and as a result they evaporate very quickly and so they affect the root system and their plants die faster.
As for heavy oils, they die slower because they affect the root and the shoot system and so it takes a longer time for all the plants to die.

EVALUATION: -

The topic I chose was a very interesting one as in my country there are many oil tankers so according to that I chose this topic as to see the harm these oil spills cause the plants that are growing. It wasn't a long one and so it didn't take long for me to complete my whole experiment. I got the results as predicted and they were accurate as I took really good care of the plants by watering the control and oiling the rest of them at the right time. So overall, I think I did a good job with the right results.

Errors: -
In my experiment, I didn't get many errors, as I made sure I carefully planted the correct amount of seeds in the right-labelled pots. I grew and observed them very carefully and kept on measuring the different readings. My only error could have been the rate at which the plants grew because as I planted kidney bean seeds, the climate was quite cold, so it took a much longer time for the plants. I think the plants would have grown at a faster rate and I could have gotten better results if I grew them in a warmer climate.

Accuracy and Reliability: -
I think my results are quite accurate because as I predicted them, the light oils had a quicker effect on the plants then the heavy oil because they are more volatile and so they don't remain in the soil for a long time. So they affect the root system and because of this all the plants died faster. As for the

plants with the heavy oils, they died slower because they stayed in the soil for a longer period of time and they it took time to affect the shoot system. So as I predicted, my hypothesis was correct and according to the results I got it was proven that light oils affect the plants more quickly then the heavy oils. So my readings are reliable.

Variability: -

My results could have varied if: -

- I used aquatic plants instead of plants that grow in soil.
- I experimented on the plants in a different climate (warmer) rather then experimenting on them in a cooler climate.
- I oiled the plants everyday rather then oiling them every alternative day.

Limitations and Improvements:-

I could have got a better result if I: -

- Used different types of plants and observed the effect of oils on each one of them separately.
- Used different types of heavy and light oils.

Appendix:-

EFFECTS OF OIL ON OTHER ORGANISMS: -

Birds:-Oil kills birds in many ways. Sea birds or diving birds spend much of their time on or near bodies of water. Consequently, of all creatures, they face the highest risks from oil pollution. The consequences they may suffer depend on the species but may include:

- Hypothermia: When a bird comes in contact with a petroleum product, the oil causes the feathers to mat, letting frigid water penetrate the waterproof external feather sand soak the downy insulating layer. As the bird struggles to maintain its body heat, it burns its fat reserves.
- Drowning: May result from the increased weight of oil on the feathers or a lack of air trapped in the feathers.
- Poisoning: As a bird tries to clean oil from its feathers by preening or as it feeds upon a contaminated food source, it ingests or inhales oil.

Fish: -Fish in their early life stages is sensitive to oil in the water column. Eggs may not hatch and young fish may die. When oil is dissolved or dispersed, however, it may be taken up through their gills or eaten, and may accumulate in the liver, gall bladder and stomach. This may result in tainting of the flesh, making the fish unacceptable for consumption...
While oil rarely kills fish outright, it can and does have long-term sub lethal effects such as reduced reproduction and loss of stamina, and may affect both feeding and respiration.

People:-In freshwater environments, perhaps the most dangerous problem are contamination of drinking water sources. Food sources, such as fish and crustaceans, may be tainted as well, which often makes the people to stop buying fish, resulting in a loss of income for fishermen, fish plant workers and others.
Oil spills affect many human activities. Harbours, marinas and tourist beaches are often closed. Fishing and hunting may be temporarily suspended, altering traditional lifestyles for Native people and resulting in lost income for commercial fisheries (especially fish farms), fishing guides and outfitters. Oil can coat boats and fishing gear and extensive cleaning may be required.

<u>Steps to prevent oil pollution: -</u>
One way to prevent pollution is to make ships and related equipment safer so that accidental spills will not occur.
The following warning signs, however, are detectable through sight, smell and sound.

- Unusual operating conditions such as erratic pump function. Equipment failure that might result in a leak can be repaired if caught early.
- Complaints from family or neighbours about oil vapours or stains on the basement wall, or water that tastes or smells of petroleum.
- Stained or dead grass around the fill pipe.
- Dead or dying bushes or trees around the tank.
- Ongoing observation of oil flow from and into a vessel;
- Regular inspection of hoses and connections;
- Monitoring of weather conditions
- Installation of dikes around storage tanks to prevent oil from escaping if an accident takes place.

STEPS TO CLEAN UP OIL SPILLS: -

- Leave it alone and let it degrade naturally.25% of crude oil in a spill is volatile and evaporation into the atmosphere within 3 months, 60% of crude oil is non-volatile, less dense then water, and floats on the surface where it is broken down by bacteria; the remaining 15% forms globules that sink to the bottom and are broken down slowly.
- Mechanical recovery: this usually involves specialized recovery vessels
- Burning-this can be 95-98% efficient, but causes black smoke and soot which may pollute coastal towns and cities.
- Aerial dispersants-dispersants are chemicals that reproduce the natural action of waves, they break oil into droplets, stabilize the stay. Dispersants prevent slicks from reforming on the surface. They do not actually make oil disappear, but move the oil from the surface down into the water, where it becomes available to naturally occurring marine bacteria, which can then degrade it. This degradation can reduce the oil to 5% of its original volume.

Once the oil has reached the shore it may be: -

- Physically removed by taking off the top layer of sand
- Dispersed using detergents or high-pressure hoses.
- Removed manually by a large workforce using a variety of techniques.

Perhaps the best method of dealing with oil spills is by bioremediation. This aims to speed up oil degradation by stimulating naturally occurring bacteria to break down the oil faster. These bacteria use oil as a food source, but they also need oxygen, nitrogen, and phosphorus. Oxygen is usually plentiful, but raising levels of nitrogen and phosphorus by applying fertilizer increases the rate at which the bacteria can feed on oil.

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