



Review Paper

A Differential Study on Microbial and Molecular Effects in Plant Grown in the Vicinity of Petroleum Contaminated Soils

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Available online at: www.isca.in, www.isca.me

Received 17th July 2015, revised 29th August 2015, accepted 4th October 2015

Abstract

The proposed paper is an exploration of microbial and sub-atomic impacts of petroleum contaminants on wheat plants developed in petroleum defiled soils. With fast improvement of industry, vehicles, and planes, the interest for petroleum is progressively extended. Then again, a lot of petroleum was impregnated to soil amid the investigation, translocation, and handling, and it brought about critical ecological contamination. Commonplace medications for petroleum-defiled soil include in uncovering the dirt and evacuating it for treatment utilizing physical or substance routines. The most widely recognized and essential indications saw in the plants debased with oil and its results, corruption of chlorophyll, adjustments in the stomatal instrument, lessening in photosynthesis and breath, increment in the generation of anxiety related, gathering of poisonous substances or their side effects in vegetal tissue, diminish in size and less creation of biomass. Soils which are presented to petroleum pollution has been concentrated altogether keeping in mind the end goal to figure out their influence on different parameters of plant development, for example, seed germination, leaf region, biomass, chlorophyll substance and stature of the plant. relative study is performed in this undertaking taking characteristic soils and in addition vermicompost to figure out the accurate results vermicompost soil has indicated more elevated amounts of the considerable number of parameters while petroleum soil readings are low than ordinary soil readings.

Keywords: Biomass, chlorophyll, environmental pollution, plant, petroleum, soil, vermicompost.

Introduction

Soil is a perplexing blend of minerals, supplements, natural matter and living beings whereupon all other physical trophic frameworks are indigent. It is a basic asset for maintaining fundamental human needs, for example, sustenance, fiber and asylum. It serves as the key supplier of substantial metals to the hydrosphere, air and living life forms, and along these lines assumes a urgent part in cycling of metals in nature. Metals discharged from different sources might at long last achieve the top soil, and their further destiny relies on upon soil physical and substance properties, for example, pH, redox potential, natural C, mud substance and cation trade capacity¹. When the metals enter in soil, they are firmly held by soil particles and there is little evacuation by plant uptake or development down the dirt profile. In low and medium sullied soils, convergence of metals in yields is generally not sufficiently high to bring about intense danger, but rather over the long haul, it may bring about ceaseless harm to human/creature wellbeing. Soil microorganisms are viewed as a touchy marker of the progressions happening in soil biological system².

Lately, with the advancement of the worldwide economy, both sort and substance of overwhelming metals in the dirt brought about by human exercises have steadily expanded, bringing about nature's decay. Overwhelming metals are profoundly

unsafe to nature and life forms. It can be improved through the natural pecking order. When the dirt experiences substantial metal defilement, it is hard to be remediated. Previously, soil sullyng was not considered as critical as air and water contamination, in light of the fact that dirt defilement was regularly with wide range and was harder to be controlled and represented than air and water contamination. Be that as it may, as of late the dirt sullyng in created nations gets to be to be not kidding. It is in this manner gave careful consideration and turned into an interesting issue of ecological assurance around the world. To comprehend the present circumstance and the effect of substantial metal sullyng of soils on the planet, in present study we will think about and break down the defilement information of different urban communities/nations, and investigate foundation, effect and remediation systems for overwhelming metal pollution of soils. Soil is described as an intricate and element framework. It is constituted by a few layers that vary in connection to the physical, synthetic, mineralogical and natural nature, which are impacted by the atmosphere and exercises of the living organisms. Other than adding to the support of all types of life that happen in the physical surface, soil assumes an essential part in securing the groundwater going about as a gatherer channel of natural and inorganic buildups, helping in sequestering conceivable dangerous mixes³.

Amid the most recent many years of the twentieth century there was a familiarity with the dirt's significance as an ecological part and acknowledgment of the need to keep up or enhance its ability to permit it to perform its different capacities. In the meantime there was an affirmation that the dirt is not an unlimited asset and, if utilized disgracefully or ineffectively dealt with, its attributes can be lost in a brief timeframe, with restricted open doors for recovery³. Be that as it may, the last transfer of conceivably lethal deposits in the dirt has turned into a commonsense and reasonable option and can bring about modifications in the arthropod group. These species can show singular characteristic changes, which can be extrapolated to handle focuses on remembering the deciding objective to separate natural. Therefore, the get-together of natural studies, both laboratorial and field, joined with engineered examination of the contaminants, gives a certifiable circumstance of the effects that the destructive substances can realize in the organic framework. Among the substances released in the earth the petroleum backups and generous metals. In soils sullied with petroleum and backups, a couple of contaminants rise appeared differently in relation to others, for instance, benzene, toluene, ethylbenzene and xylenes, known as BTEX, polycyclic sweet-noticing hydrocarbons (PAH) and total petroleum hydrocarbons (TPH)⁴. Pollution by overpowering metals is gotten from the anthropogenic activity, principally identified with the mechanical strategy and customary sources, for instance, volcanic discharges.

In spite of the way that investigates including soil quality are going up against a discriminating technologic challenge with a couple moves being made remembering the final objective to review, correct and reduce the perils of contaminants in the earth, standardized watching combined with remediation routines are still required. Thus, several inquire about hoping to remediate the earth's effects contaminants have been finished the world over. Remediation of a debased zone incorporates the use of one or more procedures hoping to remove or contain damaging substances in order to allow the reuse of the reach with tasteful peril limits for human and natural wellbeing. Thus, an immaculate remediation process must evacuate each one of the soil's contaminants or, at any rate, lessen the rate of spoiling of the earth beyond what many would consider possible; should moreover avoid the movement of contaminants to distinctive areas. For the remediation of soils sullied with petroleum and overpowering metals, a couple of physical, manufactured and natural systems have been delivered for the departure or defilement in situ or ex situ of the toxin⁵. In this setting, the part means to give a watchful change of routines for the departure or debasement of the poisons and likewise a trade on the utilization of such frameworks for the change of remediation systems and plans.

Dynamic Pollutants

Geosphere, or physical layer, is that some bit of the earth on which the people live and remove the most amazing of its advantages. Past it was assumed that the earth had vast capacity

to acclimatize the impacts of humanity. At present, the geosphere is seen as to a great degree sensitive and feeble against wounds starting from anthropogenic activities. As demonstrated by Manahan the which means of pollution can be portrayed as the augmentation in the centralization of a beyond any doubt substance to more hoisted sums than that they happen really, rising up out of an external source, all around related to the human development. There is magnificent inconvenience in expecting the behavior of a xenobiotic in the soil, subsequent to its course of action is completely capricious and heterogeneous. Thusly, the data of the physico-substance characteristics of the contaminant blends and the earth is fundamental to envision its element⁶.

At the point when the contaminant achieves the dirt, either intentionally or inadvertently, it endures the activity of geochemical and natural wonders and is appropriated by the subsurface in the vaporized, remaining or adsorbed stages, free stage and broke down stage. The dispersion of such stages will rely on upon their physico-concoction qualities furthermore on the dirt's sort⁷. Along these lines, the contaminants' portability and, hence, their lethality are straightforwardly identified with the dirt's limit in keeping up them held in their strong stage, making them inaccessible to be consumed by plants, disintegrated and/or leachate⁷. Among the components that focus the coupling of contaminants to the dirt there is the accessible surface range of the particles (m^2/g). In addition, the electrical charges of the dirt's particles lattice likewise impact in the contaminants' adsorption to the earth. It is essential that in connection to their physico-concoction properties the contaminants are delegated Dense Non-Aqueous Phase Liquid (DNAPL), when the substance is thicker than the water and Light Non-Aqueous Phase Liquid (LNAPL), when it is less thick⁸.

By and large, the contaminants' element in the dirt can be displayed by three instruments of mass transference, specifically: shift in weather conditions, scattering and weakening. Shift in weather conditions – it comprises in the component where the contaminants circumstantially take after the stream vectors and keep an immediate association with the rate of permeation in the dirt. It is the instrument in charge of the arrangement and activation of the free period of hydrocarbons⁹.

Contamination of Soil And Its Effects on the Edaphic Fauna: Soil biological community harbors a huge biodiversity and is progressively being perceived that this differing qualities is key for the capacity's support of different environments, since the spineless creatures' exercises have significant impacts in its association and structure, flow of the natural matter and in the development of plants. In spite of this significance, soil has turned into a functional and modest option for the last transfer of a few poisonous buildups, bringing about negative outcomes. Contaminants can be impervious to the decay procedures and, in this manner, can be collected in the dirt. Spineless creatures

effortlessly get to be presented to such contaminants, which can influence their natural capacity and impact by implication the biological system and change the proportion predator/prey and influence the mind boggling evolved way of life⁹. With a specific end goal to assess the biological impacts of this tainting it is produced tests that intend to measure the wealth, mortality and proliferation of the creatures uncovered.

Saturates: Aromatics are frequently appointed mono-, di-, and tri-aromatics depending upon the amount of sweet-noticing rings present in the molecule. Polar, higher nuclear weight aromatics may fall in the sap or asphaltene part. Gums: This part is incorporated polar iotas routinely containing heteroatoms, for instance, nitrogen, oxygen or sulfur. The sap bit is operationally described, and one consistent which means of saps is as the part dissolvable in light alkanes, for instance, pentane and heptane, yet insoluble in liquid propane¹⁰. Since the tars are described as a dissolvability class, spread both to the fragrant and the asphaltene division is typical. Disregarding the way that the sap part is basic as to foul petroleum properties, little work has been represented on the saps' qualities, stood out from for event the asphaltenes. In any case, some wide properties may be recognized. Saps have a higher H/C extent than asphaltenes, 1.2-1.7 diverged from 0.9-1.2 for the asphaltenes.

Figure-1 shows a hypothetical asphaltene monomer molecule. The sub-nuclear weight of asphaltene particles has been difficult to gage as a result of the asphaltenes inclination to selfaggregate, however sub-nuclear weights in the degree 500-2000 g/mole are acknowledged to be sensible. Asphaltene monomer nuclear size is in the degree 12-24 Å¹⁰.

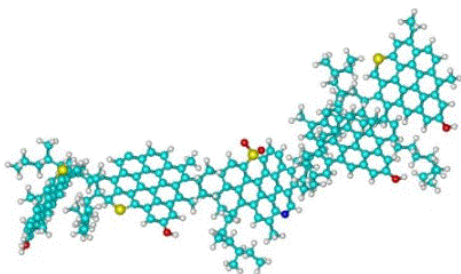


Figure-1
Hypothetical Asphaltene Molecule

Structure: Asphaltenes accepted to be as a microcolloid in the raw petroleum, comprising of particles of around 3 nm. Every molecule comprises of one or more sweet-smelling sheets of asphaltene monomers, with adsorbed gums going about as surfactants to settle the colloidal suspension. The atoms are accepted to be held together with π -bonds, hydrogen bonds, and electron contributor acceptor bonds¹¹. Under unfavorable dissolvable conditions saps desorb from the asphaltenes, prompting an increment in asphaltene total size, and in the long run precipitation of huge asphaltene totals. Figure 1.2 demonstrates a model of an asphaltene total balanced out by sap atoms.

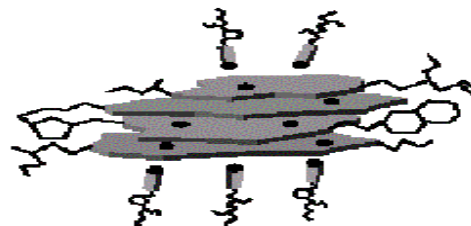


Figure-1.2
Resin Solvated Asphaltene Aggregate

An option model of asphaltene adjustment exists, alluded to as the thermodynamic model, and initially reported by Hirschberg et al.. In this approach the gums are not considered expressly, but rather are dealt with as a coordinated piece of the dissolvable medium. This perspective infers that the asphaltene monomers and totals are in thermodynamic harmony, solvated by the encompassing medium. Consequently, the discriminating refinement between the thermodynamic and steric adjustment models lies in whether the asphaltene colloids are solvated or suspended in the hydrocarbon media¹².

The principle point of interest of utilizing the thermodynamic methodology when displaying asphaltene collection is that it uses customary thermodynamic routines for stage equilibria, similar to comparisons of state. Be that as it may, since the saps are not considered expressly it doesn't adequately consider the pitch asphaltene connection, which depends on exploratory perceptions¹³.

The values' normal from bunch 1 and group 2 of typical soil are delineated in the table above. Every one of the parameters, for example, seed germination, plant stature, biomass, leaf territory, chlorophyll substance are figured in the comparable way. The seed germination is figured for day 2 to day 14 with the most elevated perusing taken was on day 14 which is 80.5%. Plant stature is figured from day 11 to 23 after the first leaf has grown totally. The most minimal stature recorded was on day 11 which is 72 mm. the most astounding recording was at day 23 with the perusing of 140.5 mm. the aggregate dry weight of the plant is thought seriously about. The plant's biomass is ascertained from day 11 to 23 which is the stage where the first hub of the plant will be obviously seen. The least biomass measured was on day 11 with the perusing 753.5 grams for each meter square and most noteworthy perusing was gotten on day 23 with the perusing 922 grams for every meter square. Leaf territory of the plant is measured from day 17 to 23 after the arrangement of second hub. most minimal region of the leaf watched was at 17 day with the perusing of 28.625 cm² and most noteworthy range of the leaf recorded was on day 23 with the zone of 33.655 cm². the chlorophyll substance of the leaves are measured from day 11 to day 23 where the first appearance of the crown is seen. the most reduced chlorophyll substance was acquired at day 11 where perusing is 31.615 nmol/cm² and most elevated chlorophyll substance was gotten at day 23 with the perusing of 36.195 nmol/cm²¹⁴.

Table-1
Average of Batch 1 and Batch 2

Day	Seed Germination [%]	Plant Height [mm]	Biomass [gm-2]	Leaf Area [cm2]	Chlorophyll content [nmol/cm2]
2	6.5	-	-	-	-
5	30	-	-	-	-
8	63	-	-	-	-
11	71.5	75	753.5	-	31.615
14	80.5	84	794.5	-	32.62
17	-	102.5	836.5	28.625	33.55
20	-	120.5	884	30.115	35.02
23	-	140.5	922	33.655	36.195

Table-2
Average of Batch 1 and Batch 2

Day	Seed Germination [%]	Plant Height	Biomass [gm-2]	Leaf Area [cm2]	Chlorophyll content [nmol/cm2]
2	4.5				
5	28.5				
8	53				
11	61.5	129	963.5		34.94
14	69.5	169.5	1021.5		36.08
17		214	1077	34.92	37.13
20		319.5	1140.5	37.37	38.465
23		401.5	1235.5	39.005	39.555

The values' normal from group 1 and clump 2 of vermicompost soil are delineated in the table above. Every one of the parameters, for example, seed germination, plant tallness, biomass, leaf range, chlorophyll substance is ascertained in the comparative way. The seed germination is figured for day 2 to day 14 with the most noteworthy perusing taken was on day 14 which is 60.5%. Plant stature is ascertained from day 11 to 23 after the first leaf has grown totally. The most reduced tallness recorded was on day 11 which is 129 mm¹⁵. The most astounding recording was at day 23 with the perusing of 401.5 mm. the aggregate dry weight of the plant is looked into. The plant's biomass is computed from day 11 to 23 which is the

stage where the first hub of the plant will be unmistakably seen. The least biomass measured was on day 11 with the perusing 963.5 grams for each meter square and most noteworthy perusing was acquired on day 23 with the perusing 1235.5 grams for every meter square. Leaf territory of the plant is measured from day 17 to 23 after the arrangement of second hub. Most minimal region of the leaf watched was at 17 day with the perusing of 34.92 cm² and most elevated zone of the leaf recorded was on day 23 with the region of 39.005 cm². The most minimal chlorophyll substance was gotten at day 11 where perusing is 34.94 nmol/cm² and most noteworthy chlorophyll substance was acquired at day 23 with the perusing of 39.555 nmol/cm².

Table-3
Average of Batch 1 and Batch

Day	Seed Germination [%]	Plant Height	Biomass [gm-2]	Leaf Area [cm2]	Chlorophyll content [nmol/cm2]
2	1				
5	15.5				
8	26				
11	38	51.5	520		26.26
14	47.5	65	593.5		27.545
17		79	662	23.385	28.37
20		93	719.5	24.72	29.775
23		107	793.5	27.395	30.855

The values' normal from cluster 1 and bunch 2 of petroleum soil are portrayed in the table above. Every one of the parameters, for example, seed germination, plant stature, biomass, leaf range, chlorophyll substance is figured in the comparative way. The seed germination is ascertained for day 2 to day 14 with the most noteworthy perusing taken was on day 14 which is 47.5%. Plant tallness is ascertained from day 11 to 23 after the first leaf has grown totally. The most reduced stature recorded was on day 11 which is 51.5 mm. the most noteworthy recording was at day 23 with the perusing of 107 mm. the aggregate dry weight of the plant is thought seriously about. The plant's biomass is figured from day 11 to 23 which is the stage where the first hub of the plant will be noticeably seen.

The most minimal biomass measured was on day 11 with the perusing 520 grams for every meter square and most astounding perusing was gotten on day 23 with the perusing 793.5 grams for each meter square. Leaf range of the plant is measured from day 17 to 23 after the development of second hub. Most minimal zone of the leaf watched was at 17 day with the perusing of 23.385 cm² and most noteworthy range of the leaf recorded was on day 23 with the zone of 27.395 cm². The chlorophyll substances of the leaves are measured from day 11 to day 23 where the first appearance of the crown is seen. The least chlorophyll substance was acquired at day 11 where perusing is 26.26 nmol/cm² and most noteworthy chlorophyll substance was gotten at day 23 with the perusing of 30.855 nmol/cm²¹⁴.

Table-4
The Comparative of Seed Germination

	Day	Natural Soil	Vermicompost	Petroleum Polluted Soil
Seed Germination	2	5.5	8	1
	5	23.5	22	15.5
	8	54.5	61	26
	11	61	69	38
	14	71.5	79	47.5

Table-5
The Comparative of Biomass

	Day	Natural Soil	Vermi compost	Petroleum Polluted Soil
Biomass	11	753.5	963.5	520
	14	794.5	1021.5	593.5
	17	836.5	1077	662
	20	884	1140.5	719.5
	23	922	1235.5	793.5

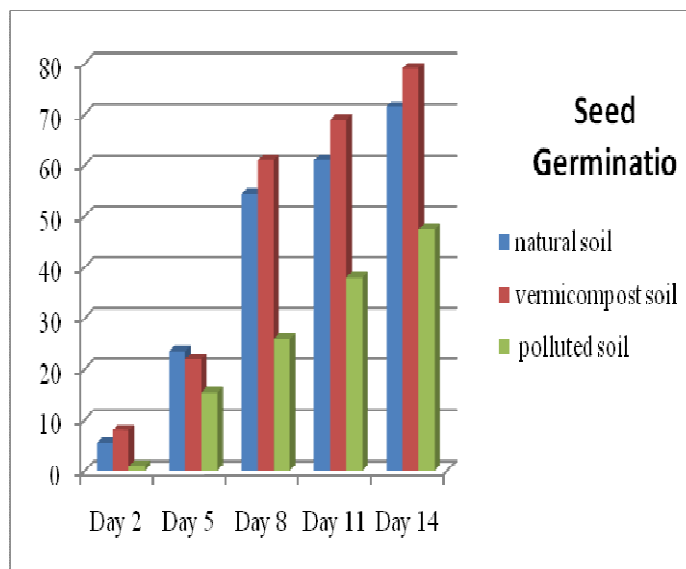


Diagram-3
The Comparative of Seed Germination

Table-5
The Comparative of Plant Height

	Day	Natural Soil	Vermi compost	Petroleum Polluted Soil
Plant Height	11	72	129	51.5
	14	84	169.5	65
	17	102.5	214	79
	20	120.5	319.5	93
	23	140.5	401.5	107

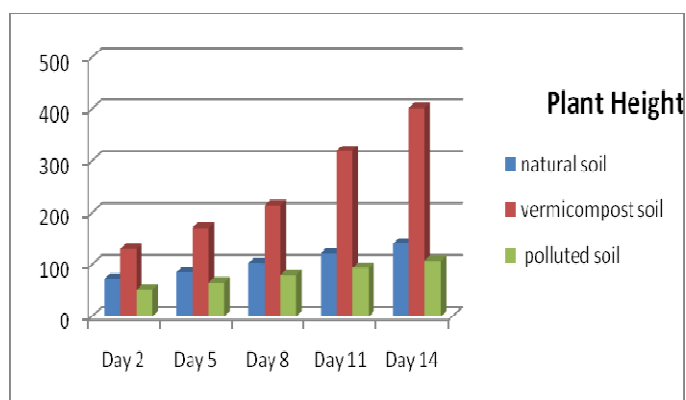


Diagram-4
The Comparative of Plant Height

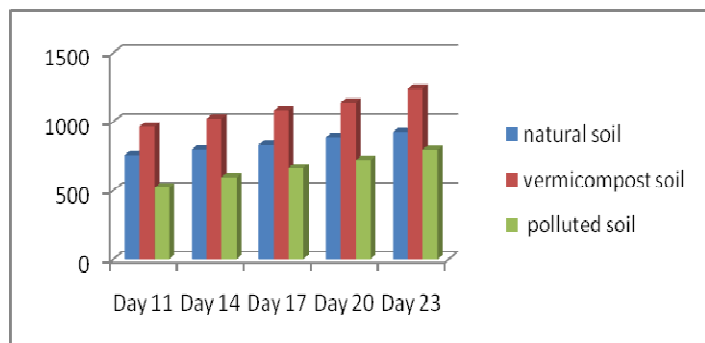


Diagram-5
The Comparative of Biomass

Table-7
The Comparative of Leaf Area

Leaf Area	Day	Natural Soil	Vermi compost	Petroleum Polluted Soil
	17	28.625	34.92	23.385
	20	30.115	37.37	24.72
	23	33.655	39.005	27.395

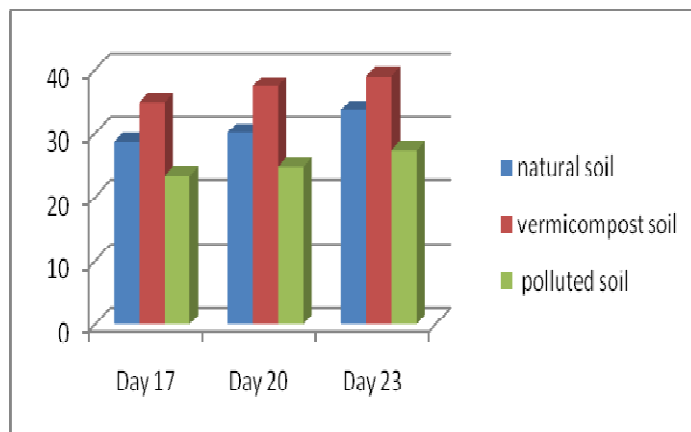


Diagram-6
The Comparative of Leaf Area

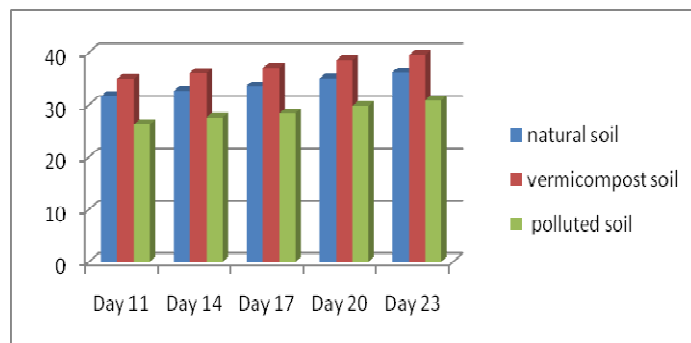


Diagram-7
The Comparative of Chlorophyll Content

Table-8
The Comparative of Chlorophyll Content

Chlorophyll Content	Day	Natural Soil	Vermi compost	Petroleum Polluted Soil
	11	32.615	34.94	26.26
	14	32.62	36.08	37.545
	17	33.55	37.13	28.37
	20	35.02	38.465	29.775
	23	36.195	39.555	30.855

Agarose Electrophoresis: The chose quality TaAQP7 is of 1019 bp length which is otherwise called Wheat Aquaporin Gene which gets communicated in the states of dry spell. Test 1 is RNA separated from plants developed in vermicompost which has been converse transcribed in the PCR has indicated lower expression while the specimen 2 where the RNA removed from plants developed in petroleum tainted soil which has been opposite transcribed in the PCR has demonstrated higher expression when contrasted with others¹⁶.

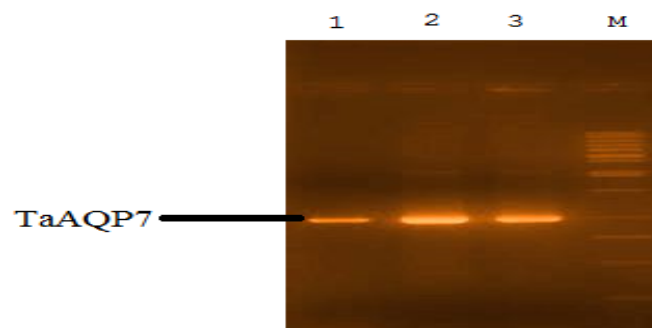


Figure-8
Agarose Electrophoresis

Discussion

The piece of discharged petroleum items shifts altogether, contingent upon the source, weathering of the item after some time, and differential development of the parts in nature. Pot-society trials were done to evaluate a few parameters of the plant development, for example, seed germination, plant tallness, leaf region, chlorophyll content, biomass weight and sub-atomic viewpoints when plants are developed in soil polluted with petroleum, vermicompost soil and ordinary soil. Correlation studies are made between the three unique sorts of soils to discover whether the dirt sullied with petroleum close to the petroleum bases can be utilized for development or not. In

this venture the petroleum defiled soil are obtained from ONGC rajhamundry while the typical and vermicompost soils are secured from a plant nursery in Hyderabad. The chose plant is wheat. They are sown into the dirts and checked frequently to calculate their development. A sum of 12 plate were readied. Four each for individual soils and the wheat seeds are sown and watered frequently while under perception. After the study's examination, the dirt with vermicompost gave the most elevated measure of perusing when watched for seed germination, plant stature, leaf zone, chlorophyll content biomass weight which are 79.401.5 mm, 39.005 cm², 39.555 nmol/cm² and 1235.5 gm/m² individually. though the petroleum sullied soils gave the most minimal readings when watched for seed germination, plant stature, leaf range, chlorophyll content biomass weight which are 47.5, 107 mm, 27.395 cm², 30.855 nmol/cm² and 793.5 gm/m²¹⁷. The sub-atomic viewpoints are screened to discover the declaration of TaAQP7 quality by separating RNA from plant running opposite transcriptase PCR and afterward checking with the assistance of agarose electrophoresis whether the chose quality has been communicated or not¹⁸.

Recommendations

Unrefined petroleum tainting influenced the development lists of the plant contrarily appeared by decreased biomass, plant tallness and leaf area. This concentrate likewise recorded lessened plant stature. diminished development is the impact of little aliphatic, fragrant, naphthalic and phenolic like mixes in unrefined petroleum that may decrease breath, transpiration and photosynthesis II and hormonal anxiety reaction this species is deserving of further study as for its utilization in phytoremediation of raw petroleum dirtied destinations The danger impact saw in tainted soils won't not be only because of the contaminant focus but rather additionally because of soil sort and properties, hydrocarbon sort, microbial group arrangement and plant species.

Conclusion

Soil contamination by raw petroleum has represents an extraordinary hazard to rural profitability and accordingly make neediness and yearning among the masses. It was seen from this trial that oil in farming soil influences rural profitability. Oil contamination in horticultural soil in whatever structure is poisonous to the plant and soil microenvironments. This study had uncovered that presentation of raw petroleum into rural soil unfavorably and seriously represses agronomic development and improvement of plants and lessens its stature, germination rate, leaf base, biomass, and also the chlorophyll content. This will most likely unfavorably influence the yields from the plant. Thusly, defilement of farming soils with raw petroleum ought to be kept away from and open mindfulness ought to be made on the inconvenient impacts of raw petroleum contamination in our physical biological community. Inventive and natural benevolent remediation systems ought to be completed on our

rural soils that have been horribly contaminated by unrefined petroleum abuse and investigation.

References

1. Dixit R. Khurana, S. Jaskarn and S. Gurusahib, Comparative performance of different paddy transplanter developed in India – a review, *Agric. Rev.*, **28(4)**, 262-269, (2007)
2. K.M. Amin and M.A. Haque, Seedling age influence rice (*oryza sativa*) performance, *Philippines J. Sci.*, **138(2)**, 219-226, (2009)
3. Aceves MB, Grace C and Ansorena J, et al.. Soil microbial biomass and organic C in a gradient of zinc concentration in soils around a mine spoil tip, *Soil Biology and Biochemistry*, **31(6)**, 867-876 (1999)
4. Aeliona CM, Davisa HT and Mc Dermottb S., Metal concentrations in rural topsoil in South Carolina: potential for human health impact, *Science of the Total Environment*, **402**, 149-156 (2008)
5. Arao T., Ishikawa S. and Murakam I.M., et al., Heavy metal contamination of agricultural soil and counter measures in Japan, *Paddy and Water Environment*, **8(3)**, 247-257 (2010)
6. C. Parida and H. Das, Development and performance of an experimental automatic paddy transplanter, *J. Agril. Engg.*, **14(2)**, 74-76, (1977)
7. Behera K. and Varshney B.P., Studies on optimization of puddled soil characteristics for self-propelled rice transplanter, *AMA.*, **34(3)**, 12-16, (2003)
8. Baath E, Frostegard A and Diaz-Ravina M, et al. Effect of metal-rich sludge amendments on the soil microbial community. *Applied and Environmental Microbiology*, **64**, 238-245 (1998)
9. Babula P and Adam V, et al. Uncommon heavy metals, metalloids and their plant toxicity: A review, *Environmental Chemical Letter*, **6**, 189-213 (2008)
10. Bauman B., Soils contaminated by motor fuels: research activities and perspective of the American petroleum institute. In: *Petroleum Contaminated Soils*. Vol. 1. (Kostecki, P. T. and Calabrese, E. J., Eds.) Chelsea, MI, Lewis Publishers, 3-19 (1984)
11. Bauman B., Research needs: motor fuel contaminated soils. In: *Hydrocarbon Contaminated Soils*. Vol. 1. (Kostecki, P. T. and Calabrese, E. J., Eds.) Chelsea, MI, Lewis Publishers, 41-56 (1991)
12. Bidleman T.F. et al. Vapor-particle partitioning of semi-volatile organic compounds: estimates from field collections, *Environ. Sci. Technol*, **10**, 1038 (1986)
13. Block R.N., Allworth N. and Bishop M., Assessment of diesel contamination in soil. In: *Hydrocarbon Contaminated Soils*. Vol. 1. (Kostecki, P. T. and Calabrese, E. J., Eds.) Chelsea, MI, Lewis Publishers, 135-148 (1991)

14. Boyd R.S., Heavy metal pollutants and chemical ecology: Exploring new frontiers, *Journal of Chemical Ecology*, **36**, 46-58 **(2010)**
15. M. Donald and A. Humblin, In search of yield, J. Australian Inst, *Agric. Sci.*, **28**, 171-178, **(1962)**
16. P. Singh and I.K. Garg, Field evaluation of a japanese paddy transplanter, *J. Agric. Engg.*, 13(1), 15-18, **(1976)**
17. CEPA (Chinese Environmental Protection Administration). Elemental Background Values of Soils in China. Environmental Science Press of China, Beijing, China, **(1990)**
18. CEPA (Chinese Environmental Protection Administration). Environmental Quality Standard for Soils (GB15618-1995). Environmental Science Press of China, Beijing, China, **(1995)**