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PHYSICO-CHEMICAL NATURE OF OIL REFINERY EFFLUENTS AND IT'S EFFECTS ON SEED GERMINATION OF CERTAIN PLANT SPECIES

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ABSTRACT

The research work focused oil refinery effluents effects on physicochemical properties of soil. The effluents are usually considered undesirable for arable land, plants and animals. The surrounding environments of an oil refinery are continuously effected by the adding of its effluents. Effluents contain many different chemicals at different concentrations including Sulphates, Chlorides and hydrocarbons and Sodium etc. The Pak-Arab Oil Refinery Muzzafar Garh, Pakistan is continuously disposing off its effluents in River Indus that may be harmful to vegetation of down flow areas. We studied that physico-chemical nature of refinery effluents and its effects on seeds germination of *Gossypium hirsutum* L., *Zea mays* L. and *Sesamum indicum* L. and found that the more concentrated effluents of oil refinery was significantly effect (P>000***) on seed germination of three tested plant species. More over *Zea mays* showed the little effect than the other two species.

Keywords: Pak Arab oil refinery, effluents, pollution, seed germination.

INTRODUCTION

Industrial effluents are usually considered as undesirable for arable soil, plants, animals and human health because these contained heavy and trace metals like Cr, Mn, Fe, Cu, Co, Zn, Ni, As, Cd and Pb are discharged continuously into water source (streams/ nullahs, canals and rivers) are allowed to spread on agricultural lands. The unplanned disposal of these effluents has increased the threat of environmental pollution (Gulfraz *et al.*, 2003).

Industrialization during 19th century changed mankind's life style. New technology raised man's standard and made life more comfortable but with increasing industrial development, safe disposal of industrial waste water has become the more ecological challenge. Environmental degradation has now become a global problem and maintaining ecosystem health is a serious issue being confronted by the environmentalists (Kumar, 2011)

Petroleum, generally referred to as "crude oil", is a mixture of hydrocarbons, oils and chemicals obtained below the sub-surface of the earth. Crude oil contains a mixture of complex hydrocarbon molecules. The hydrocarbons are classified into the following: Normal alkanes, branched alkanes, cycloalkanes and the aromatics (benzene, phenol, toluene, xylene and catechol (Njoku, 2004).

Crude oil spill is the release of crude petroleum hydrocarbons into the environment due to human activities and are classified into two main types; the land (on-shore) and the marine (off-shore) oil spills. Land oil spill occurs when crude oil is released on land which affects soil ecosystem. The different ways by which crude oil enter the environment are from natural seeps (1%), atmospheric input (1%), off-shore production (1%), coastal and estuarine effluents (3%), non-refinery industrial wastes (5%), municipal wastes (5%), urban run-off (5%), rivers (26%) and oil waste discharge from oil industries (53%) (Okereke, 2006)

Environmental pollution is a matter of great concern and has been accepted as a global problem because of its adverse effects (Irshad *et al*., 1997). In literature various studies showed that biologists, all over the globe, are monitoring the industrial effluents by chemical analysis and studying the effects on biota of effected area (Lenwood and Dennis, 2005). However many studies are available about the effect of effluents on seed germination of important crops (Rajesh, 1995; Barnah and Das, 1997; Ruhina, 1995; Crowe *et al*., 2002)

Due to continuous increase of fuel demand, the developing countries like Pakistan are establishing the oil and gas industries and their effluents can be environmental hazardous as studied by Lenwood and Dennis (2005). Therefore the management of oil and gas industrial environments requires constant monitoring of their effluents. The essence of such monitoring is to ascertain the level of compliance of such industries with the pollution control guide lines set by regulating agencies (Uyigue, 2002).

Pak-Arab Oil Refinery (PARCO) is situated in district Muzzafar Garh, Punjab and has been in operation since 19th February 2001. The refinery disposed off its treated effluents in an irrigated water channels. No previous study about its effluents physico-chemical nature and effects on living organisms is available in literature. Therefore, in this study we are firstly reporting the physico- chemical analysis of Pak-Arab Oil Refinery (PARCO) effluents and its effects on seed germination of three important crops usually cultivated in affected area.

MATERIALS AND METHODS

The effluents samples were collected in polythene container from Pak-Arab Oil Refinery (PARCO) in 2009. The containers were fully sealed and stored at temperature 25-30^{0}C. Following steps were involved in study of physico-chemical nature of effluents and their effect on seed germination of *Gossypium hirsutum* L., *Zea mays* L. and *Sesamum indicum* L.

Physico-chemical analysis of effluents

The colour, smell and pH, of the effluents were recorded. Later on the effluents were filtered to get the filtrate that was used in chemical analysis. In the filtrate the total soluble salts (TSS) were determined by gravimetric method, pH by using H.M-10K digital pH meter. Electrical conductivity of the effluents was determined by using CM-30Et digital conductivity meter. Jenway PFP7 Flame Photometer was used for the measurements of exchangeable sodium (Na^+) and Potassium (K^+). Carbonates and bicarbonates by titration with acid, Chloride by titration with silver nitrate, Calcium + Magnesium by titration with versanate and Sodium absorption ratio (SAR) determined after Jackson (1962).

Effects of effluent on seed germination

The effluent collected from the source was considered as 100% concentrated. It was diluted to 75% and 50% with distilled water. These dilutions of effluent along with distilled water (control) were used as the growth medium for seed germination by using standard technique (Hussain *et al*., 1987). There were five replicates and each replicate was with 20 seeds. The dishes were incubated for 72 hours and germination of seeds was recorded.

Statistical methods

Two statistical methods were adopted in comparing the results of three tested plant species having three treatments with the control. The mean and standard deviation values of seed germination (Mean+SD) were recorded. Apart from this, Two-way analysis of variance was also used to compare results among the seed germination of three tested cash crop species. The research data was statistically analyzed by the using of MINITAB (ver.14) of the computing software.

RESULTS

Physico-chemical nature of effluents

The 100% concentrated effluent was generally colourless with putrid smell having slightly acidic nature (pH=6.49). The contents of effluents with their concentrations were presented in Table-1.

Table-1. Physico-chemical analysis of effluents from Pak-Arab oil refinery (PARCO) Muzzafar Garh.

Physico-chemical property	Concentrations	Physico-chemical property	Concentrations
T.S.S.	2.41 meq/l	Carbonates	Nil
Na^+	28.93 meq/l	Bicarbonates	3.14 meq/l
K^+	8.70 meq/l	EC	7.1223 ds/m
Ca^{++} + Mg^{++}	5.6 meq/l	R.S.C.	Nil
Chloride	5.6 meq/l	SAR	17.29 meq/l
Sulphates	25.79 meq/l	-	-

Effects of effluents on seed germination

The effects of different concentrations, 100%, 75%, 50% and pure water on seed germination belonging to *Gossypium hirsutum* L., *Zea mays* L. and *Sesamum indicum* L. are presented in Table-2.

Table-2. Mean values plus standard deviation of seeds germination at 4 different treatment concentration of effluents of oil refinery.

Effluent concentration	Percentage of seeds germination ± SD		
	Gossypium hirsutum	***Zea mays***	***Sesamum indicum***
Tape water	98.6±50.92	98.2±50.71	98.6±50.91
100% effluents	72.6±37.49	87.6±45.23	74.6±38.52
75% effluents	83.2±42.96	95.8±49.47	83.2±42.96
50% effluents	94.4±48.74	98.4±50.81	93.4±48.23

The results showed that with the decreasing of concentrated effluents, the germination of seeds was significantly increased and vice versa. In tape water germination in all the three species such as *Gossypium hirsutum* L., *Zea mays* L. and *Sesamum indicum* L. were more or less equal (Table 2, 98.6±50.92). But the more concentrated solution of oil refinery effluents decreases the germination rate in the tested species (Table-2). Two-way of analysis was also support the above findings like treatments were significantly effect (P>000*** Table-3, Figure-1) on the seed germination of the three cash crop. However, *Zea mays* showed little effect in all the treatments than the other two varieties.

Table-3. Two-Way analysis of variance between germination versus treatment and species

Source	DF	MS	F-Value	P-Value
Treatment	3	1241.66	236.13	0.000***
Species	2	397.95	75.68	0.000***
Interaction	6	80.39	15.29	0.000***
Error	48	5.26		
Total	59			

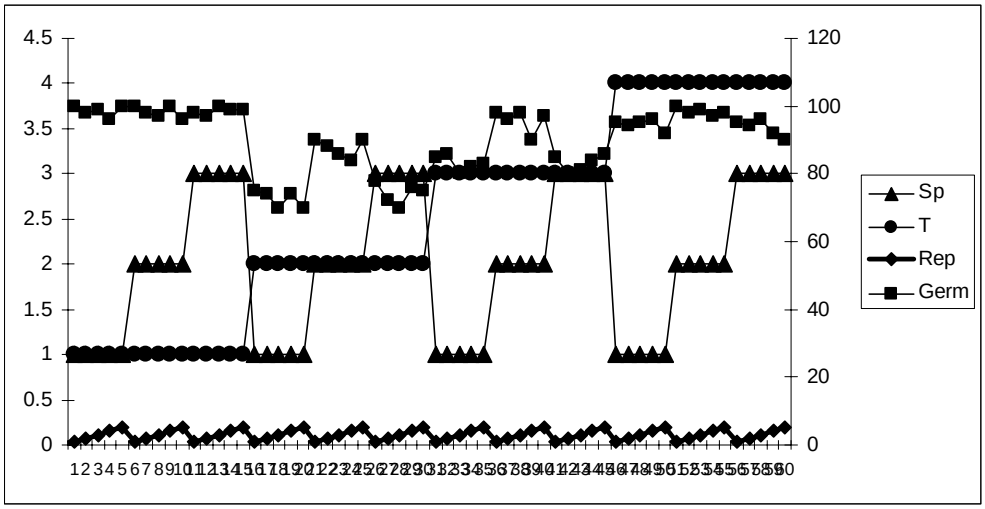

Figure-1. Germination of three species in different treatments into 5 replicates.

DISCUSSIONS

The impact and long term ecological ramification of pollution on the biosphere have resulted an increased interest to evaluate the interactions between pollutants, the environment, and the biota (Ahmad *et al*., 2005). Pakistan is a developing country and in passed mostly industrial units is established without environmental impact assessment (Mastoi *et al*., 1997). Now a day both the government and industrial sector claim that all protective environmental measures are opted before the establishment of new industries.

Pak-Arab Oil Refinery a newly established industry in Pakistan also declares that the effluents are properly treated before disposal. The results of this study partially proved the refinery declaration that heavy metals were not detected in effluent. However the concentration of soluble salts, Carbonates, Bicarbonate, sodium, Potassium, Chloride, Calcium, Magnesium etc. in effluent seems alarming.

This study also revealed marked delay in seed germination in 100% concentrated effluent and decline in the germination percentage by 10-25% as compared to control possibly due to presence of high concentration of chemicals in effluent that certainly altered the soil condition and disturbed the seed-water relationship affecting the germination process (Barnah and Das, 1997). The results of this study in regard to effect of effluent concentration on seed germination are in complete agreement with previous study (Rajesh, 1995; Barnah and Das, 1997; Ruhina, 1995; Crowe *et al*., 2002). More over previously Nwazue (2011) reported that the polluted soil had lower pH value, low moisture content and more organic carbon than the unpolluted soil. The results obtained in this study showed in Figure-1 was fully agreed with the previous study, that oil spillage/pollution had an adverse effect on the soil chemistry, plants species, vegetables, water (aquatic medium) and more especially on the ascorbic acid content of the test vegetable plants.

The change in relative growth found for the plant species is an index of pollution. It is also a measure of loss in biomass of the vegetable samples. The different vegetable species used in this study exhibited the same level of change in relative growth as a result of oil pollution with the following values: *Spinacea olereceae* (0.12±0.02); *Solanum melongena* (0.15±0.07) and *Talinum triangulare* (0.16±0.05), respectively. Petroleum pollution inflicts anatomical, physicochemical and ecological changes on the soil, plants, animals and other inhabitants of both aquatic and terrestrial environments (Nwazue, 2011).

CONCLUSIONS AND RECOMMENDATIONS

It is therefore recommended that in order to protect the crops in agricultural land, do not discharge refinery effluents directly in to the water channels like streams and canals. The refinery is asked to establish better water treatment plants and water storage pool, so that the level of chemicals in effluents could be minimized before its discharge in to fresh water bodies.

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